THE ART OF LITHOGRAPHY

ALOYS SENEFELDER
INVENTOR OF LITHOGRAPHY

THE ART OF LITHOGRAPHY

A COMPLETE PRACTICAL MANUAL OF PLANOGRAPHIC PRINTING

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ONE HUNDRED AND TWENTY ILLUSTRATIONS AND TWO FOLDING PLATES

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PREFACE.

TEN years ago the lithographic trade was in a critical position, and it was an open question whether it would improve or go under. Thanks, however, to a number of remarkable inventions, in processes, in machinery, and in the purely chemical aspects of the art, a great revival was brought about, with the result that lithography is better able to hold its own in the printing world to-day than at any period in its past history. The most pressing need of the trade at the present time is an ample supply of workmen of all-round competence, and it is with the object of helping to meet this need that the author has undertaken the preparation of this manual.

The work is the result of long experience both in the workshop and the technical classroom, and the author has sought to make it comprehensive, thoroughly up-to-date, and, above all, practical. Every lithographic operation is described in the fullest detail, and useful practical hints will be found on almost every page. It completely meets the requirements of the lithographic syllabus of the City and Guilds of London Institute in all grades.

Certain processes of great importance and value are described in the book for the first time, particularly the simpler and cheaper transferring method dealt with in Chapter XI and the practical aerograph process set forth in Chapter V. The important question of the training of apprentices is also fully dealt with. Special attention is directed to the very full combined index and glossary.

The author gratefully acknowledges the invaluable assistance of many firms and individuals, especially in

those chapters that treat of subjects not within his own immediate knowledge and experience. Mr. Walter Murray has supervised the work throughout from an editorial standpoint and has read all the proofs, besides preparing the index. Special mention should also be made of Messrs. James Brown & Co., Esk Paper Mills, Penicuik; Messrs. Morris & Bolton, Ltd., London; and Messrs. Furnival & Co., Ltd., Reddish. Hurst's treatise on "The Theory of Colour" (Scott, Greenwood & Son), Sindall's "Paper Technology" (Charles Griffin & Co., Ltd.), and Hind's "A Short History of Engraving and Etching" (Archibald Constable & Co., Ltd.) have been of the greatest service.

H. J. R.

January, 1914.

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CHAPTER I.

THE BASIS OF LITHOGRAPHY.

Planography.—The art of printing from a polished calcareous stone was invented by Aloys Senefelder, a native of Prague, Bohemia, about the year 1796. The name Lithography (from the Greek words, *lithos*, a stone, and *grapho*, I write) was given to the process, and this is still in general use, although to-day it by no means adequately represents the art as it did up till about a quarter of a century ago, because of the extensive and ever-increasing employment of zinc and the introduction of aluminium as printing surfaces. Accordingly, the word might with advantage be replaced by another which will convey a broader meaning. The term Planography (from the Latin word, *planus*, level, flat, plane) has been much in evidence of late, and there is no reason why it should not be generally adopted to denote all processes of printing from flat surfaces.

A Chemical Process.—Lithography (or planography), being a flat-surface process, occupies an intermediate position between letterpress or relief printing and copperplate or intaglio (sunk) printing; but with this essential difference, that while letterpress and copperplate printing are mechanical processes, planography is of necessity a chemical one.

If a printer's inking roller is passed over a letterpress forme, the raised face of the type, which represents the actual work, is immediately charged with ink, whilst no ink is deposited on the supporting base of the plate. But if the roller is passed over a plane, level surface, such as a lithographic stone or a marble slab, which has not undergone any previous preparation, it will deposit ink over the entire surface. Therefore, in planographic printing two forces or materials are necessary: one that will attract printing ink to the parts where it is required, that is, to the work which is to be printed, and another that will repel it from all other parts; and this can only be brought about by the aid of chemistry. The separation between the printing and the non-printing surface, which is effected in letterpress printing by means

of the mechanical device of relief, is effected in lithographic printing by the action of suitable chemicals.

Some Chemical Terms.—Before proceeding to explain the chemical actions employed in lithography, it is necessary to define some chemical terms for the guidance of non-chemical readers.

Chemically all substances are classed as *elements* and *compounds*. An element is a simple substance, such as sulphur or oxygen, that cannot be resolved into any other substance. A compound is a chemical combination of two or more elements. For example, sulphuric acid consists of hydrogen, sulphur, and oxygen combined in certain definite proportions. A compound of an element with oxygen (one of the gases in the atmosphere) is called an *oxide* of the element. Thus water is an oxide of hydrogen. So compounds with sulphur are called *sulphides*; compounds with chlorine, *chlorides*; and so on. Compounds of elements with hydrogen and oxygen are called *hydrates*. Thus caustic soda is the hydrate of a metal called sodium.

A large class of chemical compounds called *salts* are produced by the combination of a *base* with an *acid*. A base is usually the oxide or hydrate of an element: for example, ferric oxide, which is an oxide of iron occurring in many iron ores, and caustic soda. An acid is a compound of hydrogen, usually with a sour taste, that has the property of turning a vegetable blue, such as litmus, to a bright red. When a base combines with an acid, the element in the base displaces the hydrogen in the acid, and forms a salt. Thus, when caustic soda combines with hydrochloric acid (a chloride of hydrogen), the sodium in the caustic soda takes the place of the hydrogen in the acid, and sodium chloride (or common salt) is formed. So also, when lime, that is, oxide of calcium, combines with sulphuric acid, a salt called *sulphate* of calcium is formed.

Certain bases, such as caustic soda, reverse the reddening action of acids on vegetable blues, and restore the blue colour. These are called *alkalis*. Substances which are neither acid nor alkaline in their action on litmus are said to be *neutral*.

For lithographic purposes a distinction between *fatty or oily acids* and *water acids* is useful. The former are fats and oils, such as stearine (or stearic acid) and oleine (or oleic acid), possessing a sour, rancid taste and an acid reaction. The latter are acids either soluble in water or intimately miscible with it. Examples of these are the familiar substances, nitric acid, sulphuric acid, and citric acid.

Action of Oleic and Arabic Acids.—Acids play the most important part in the chemistry of lithography, inasmuch as they combine with the base or element in the printing surface

to form other compounds which are absolutely necessary for the successful working of the process. Certain fatty or oily acids form the ink-attracting and water-repelling compound; and certain water acids form the ink-repelling and water-attracting compound. If a drop of oleic acid (or oleine) is put on a prepared lithographic stone (which mainly consists of limestone, that is, carbonate of calcium), or on a zinc or aluminium plate, an oleate of calcium, zinc, or aluminium is almost immediately formed; then, if the remaining portions of the surface are treated with a suitable water acid (arabic acid, contained in gum arabic solution), an arabinate of calcium, zinc, or aluminium is formed. If the stone or plate is then dampened with clean water, and the inking roller passed over it, it will be found that the roller deposits ink only on the oleates (the parts which have been acted upon by the oleic acid), and that the remaining portions, so long as they are kept damp, repel the ink. This, then, is the fundamental principle upon which planography is based.

An Outline of the Lithographic Process.—Before proceeding further, it will be helpful to give here a general outline of the process of lithography. This will enable the reader to understand in some measure technical terms that have to be introduced in advance of their full explanation. The original "copy" for the lithographic artist may be a drawing or a sketch, a photograph or a model. The work must be first drawn upon lithographic stone, or upon a zinc or aluminium plate, or upon a specially prepared paper called *transfer paper.* Special soapy inks and crayons are used by the artist for drawing the original work.

A *proof* is a completed print taken from the original drawings on the stone or the metal plate, and a *transfer* is an impression or print pulled on transfer paper from an original drawing, or from a letterpress forme, or from an engraving done on stone or on copper or steel plate. These transfers are all pulled in special greasy inks called *transfer inks.* A transfer may also be written or drawn with soapy inks and crayons on transfer paper. The transfers are *patched* or fixed in position on a sheet of the paper to be printed on, and afterwards transferred to a printing stone or metal plate.

The stone or plate is then placed in the printing machine. There are several kinds of printing machines. In those known as *flat-bed machines* the printing surface travels backwards and forwards in the bed of the machine; but in others, called *rotary machines,* the printing surface (which in this case must be a metal one) is bent round a cylinder. Some machines print direct from the printing surface on to the paper, whereas in

others the work on the stone or plate prints on to a rubber blanket on a cylinder, and this in turn transfers the impression to the paper. The former are called *direct* printing machines, and the latter *offset* printing machines. Where a job is in several colours, each colour involves a separate printing forme and a different ink.

CHAPTER II.

LITHOGRAPHIC STONES.

The Solnhofen Quarries.—Lithographic stone is composed almost entirely (about 97 per cent) of carbonate of lime, otherwise called carbonate of calcium. It is a stratified rock, that is, one that has been deposited in layers, and the world's supply comes chiefly from a small district in Central Bavaria, where

FIG. 1.—Map of Central Europe, showing position of Solnhofen.

there are a number of quarries (Fig. 2). The centre of this district is a place called Solnhofen (Fig. 1), some sixty miles north-west of Munich, and about ten miles north of the River Danube, from which river-bed the sand is obtained for the purpose of grinding the face of the stones before they leave the quarries. The texture of the stone is very compact and homogeneous; it is hard,

FIG. 2.—Lithographic Stone Quarry (A. W. Zehntner & Co.).

yet easily fractured; and it varies in colour from blue-grey to pale buff. It is easily worked and cut into sizes to suit the requirements of the printer.

The Origin of the Solnhofen Stone.—It may be of interest to the young lithographer to have some idea as to how this rock, which has proved to be of such great value to the world, came to be there. The geological age in which it was deposited is that called by geologists the Jurassic, from the Jura Mountains, on the frontiers of France and Switzerland. The Jurassic Age is much more recent than the Coal Measures, but it ended long before the advent of man on the earth. Fig. 3 gives a rough idea of the geological position of the Solnhofen limestone.

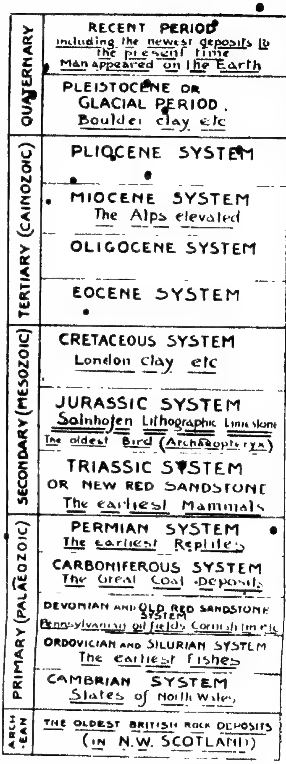


FIG. 3.—Relative Geological Position of the Solnhofen Lithographic Limestone.

The regions in which German lithographic stone is now found were, perhaps millions of years ago, covered with large lakes or seas, or the estuaries of rivers which flowed into the seas. These rivers would, after continued heavy rains, become much swollen, and carry down to the lakes or seas great quantities of stones, sand, mud, minerals, etc., which would be deposited by gravity in regular order. If we take a large clear-glass bottle and fill it three parts full of water, and stir into this one or two handfuls of earth, we shall find upon allowing all to remain undisturbed for some time that the water has again become quite clear, and the earth which we mixed with it has been deposited in layers. The sand and grit went quickly to the bottom; the less heavy particles gradually fell on top of the sand; and so on, until there was nothing left in the water but the very finest and lightest sediment, which slowly settled down on top of all.

Now, if we go down, after several days of heavy rain, to the mouth of a small river or stream, where it runs into the sea, its course far out into the ocean may easily be followed with the eye, because of the brown, muddy line it has made for itself through the clear water. The same thing is happening here as took place in the bottle, but this time it is in a current instead of in still, confined water; and we may easily imagine that, once out of the great force and dash of the stream, the coarse and heavy particles in the form of small pebbles will soon settle at the bottom, and a little beyond, where the current is less strong, the sand will gather. But the water is still heavy and thick with fine insoluble matter. This, too, although it may be miles farther out, will all gradually settle.

It is estimated that, on an average, every 100,000 lb. of river water contains 21 lb. of mineral matter, of which 11 lb. is carbonate of lime; the balance being made up of carbonate of magnesium (a constituent of litho stone), sulphate of magnesium, common salt, silica, etc. When we consider that the amount of mineral matter in solution carried annually to the sea by such a river as the Thames is estimated at 548,230 tons, we are able to form some idea how sedimentary stone, such as we use for lithographic printing, was gradually built up. This gradual building up may go on for thousands or even millions of years, the weight and pressure increasing as time goes on, causing the under layers to become very firm and hard; until at length a gradual upheaval of these parts takes place, and the deposits are exposed as dry land.

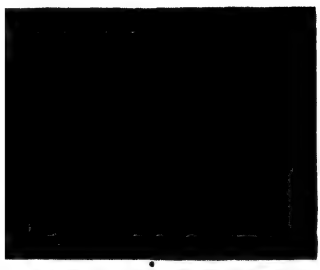
The Archæopteryx.—Many interesting fossils, representing both land and water life, are found in lithographic stone. Of these the most interesting by far is the *Archæopteryx* (see in Fig. 4), of which there are only two specimens in existence, one in the British Museum in London, and the other in the Royal Mineralogical Museum in Berlin. The *Archæopteryx* is the earliest known bird, and still retains many reptilian characters, so establishing the evolution of birds from reptiles. It was about the size of a rook.

Qualities of Stones.—Besides Bavaria, lithographic stone is found in Spain, France, Italy, America, and England (Somersetshire), but it is all of a more or less inferior quality, and need hardly be considered in connection with our subject. Even from the best quarries in Bavaria the quality varies considerably, both in texture and colour. The best stones are of a pale yellow colour and free from chalk marks or veins, but there is also a light grey variety, which is harder than the yellow stone, and is in great demand by American lithographers, as work is inclined to print sharper from it. This suits their fine commercial en-

LITHOGRAPHIC FOSSILS.

Archæopteryx.
(Royal Mineralogical Museum, Berlin.)

Archæopteryx.
(British Museum.)



A Sea-lily (*Antedon pennata*).

A Fish (*Leptolepis*).

A Crustacean (*Mecochirus*).

FIG. 4.—The *Archæopteryx* or Earliest Known Bird and other Fossils found in Solnhofen Limestone.

gravings, which are so much admired in Britain. Both of these qualities are unfortunately getting very scarce and costly, but nevertheless it pays the printer to buy only the best; and this being so, the greatest possible care is exercised by the quarrymen when taking out large slabs. These slabs are rarely more than 5 or 6 inches in thickness, the superfluous stone from the thick ones being chipped away until the necessary thickness is obtained.

Backing Thin Stones.—A stone of otherwise good quality but too thin is sometimes cemented to another thin stone of inferior quality. This is done by first grinding the stones, one on top of the other, with sand and water until they are perfectly true with each other. The sand is then washed off and the surfaces dried or left wet according to the nature of the cement to be used. A quantity of the cement is put upon one of the newly ground surfaces, and the other stone is again placed on top. The top stone is then worked about until the cement has spread evenly but thinly all over both of the surfaces, so that the stone can only be moved with difficulty. They are then left in position with weights on top for a few days until the cement has hardened. A cement which is said to be useful for this purpose (*Paget's Mastic*) may be made as follows. Knead to a paste 21 parts chalk, 63 parts sand, 5 parts white lead, and 2 parts litharge, with a saturated solution of acetate of lead, and finally mix with 6 parts linseed oil. The surfaces should be dry when this cement is applied.

Preparation of Stones.—The working surface is got by covering the stone with Danube sand and grinding. Hand grinding is done with another stone on top, but in up-to-date quarries the grinding is done by machinery carrying a number of small stones attached to circular grippers. When an unusually thick slab is found, it is cut into stones of ordinary thickness by means of a diamond-toothed saw.

Importance of Uniform Thickness.—It is much to be regretted that more attention is not given to the uniformity of thickness of large stones before they leave the quarries, as many a valuable one might be saved by the exercise of a little more care. It not infrequently happens that, owing to the stone not being of uniform thickness, it breaks in the printing machine or press the first time that work is done from it. Such a disaster might, of course, have been averted had the user taken the time and trouble to grind it level, but facilities for doing such work are to be had in only a very few shops.

Testing Stones.—When a new stone of any size is purchased, it should first be tested at both ends with the callipers, and if found to be thicker at the one end than the other, the thick end

must be ground with sand and water, or planed in a planing machine until it is of the same thickness as the opposite end. This may be done from either side of the stone, but it is generally better to grind the back. The grinding can be effected by means of a hand levigator (Fig. 5) or by a stone-grinding machine. Fig. 6 shows a very simple but useful type of stone-grinding machine. Being fixed to the ceiling, it occupies no floor space, and it is easily manipulated by a person of ordinary intelligence.

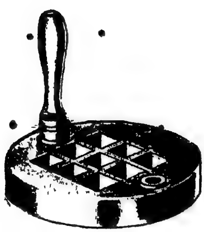


FIG. 5.—Hand Levigator.

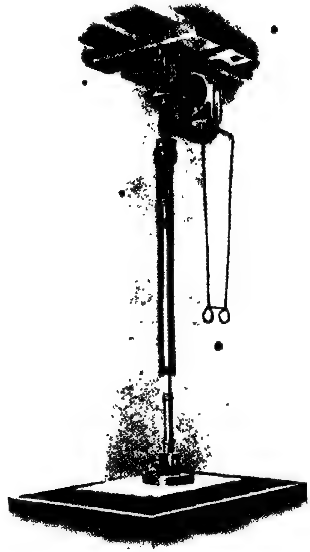


FIG. 6.—Stone-grinding Machine.

The operator, having grasped the handle which is just above the disc, sets the machine in motion and then guides the revolving levigator (disc) over the surface, applying sand and water as required. The rod, being telescopic, will accommodate itself as it is guided from the perpendicular. Fig. 7 shows a useful type of stone-planing machine.

Having ground the stone, make the next test by placing a straight-edge on top of half a dozen strips of paper at intervals over the length of the stone, a few inches in from the edge, try

ing each slip by pulling slightly (Fig. 8). The loose pieces indicate hollows and the tight ones the high parts, which must be marked for further grinding. This is to be repeated in the centre and at the opposite side. Having made the back right, turn the stone over and treat the working surface in the same

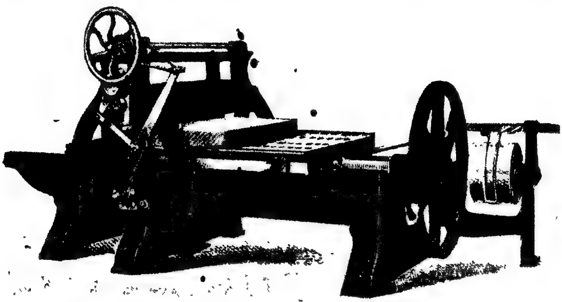


FIG. 7.—Stone-planing Machine.

manner, after which it may be finished off by rubbing with a block of artificial pumice stone and water until all traces of sand holes have been removed. Finally, give the necessary finish with Scottish Tam o' Shanter stone. The stone must then be washed with a plentiful supply of pure water, when, after drying, it will be in a condition to receive lithographic work.

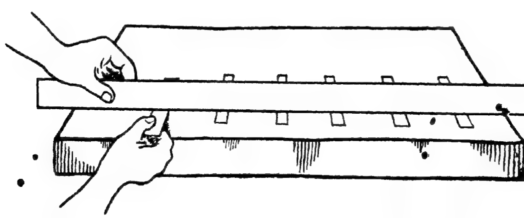


FIG. 8.—Testing the Surface of a Stone for Evenness.

Stone-polishing by Chemical Means.—Old work on lithographic stones may be cleaned off and the stone reprepared for new work almost entirely by chemical means, and while the

method is considered not so satisfactory as grinding and polishing, good results may be obtained by it, and a great deal of time saved, especially when a number of forms are to be set up and only a short run required from each. A large stone that would occupy from two to three hours to prepare by the grinding and polishing method may be prepared in fifteen minutes by chemical means.

There are several preparations on the market for this purpose, the best known of these being an acid preparation called *Liasine*. It is used as follows. Polish the stone with a block of Water of Ayr stone and water until the relief caused by etching the old work has been rubbed down to the level of the remainder of the stone (this is essential with all chemical polishes, and only occupies a few minutes); then sprinkle some pumice powder over the stone; pour on a quantity of liasine, distribute it quickly all over the surface with a felt pad, and rub vigorously for a few minutes. Wash with pure water and dry, when the stone will be ready for transferring upon.

A good chemical polish may be made up as follows: Dissolve ½ lb. of caustic soda in 6 lb. of water, and then add ½ lb. of liquid carbolic acid (pure, not the brown quality). This preparation is used in the following manner. Select the stone to be used for the purpose, which should be properly ground level and polished in the usual way. Now pour upon it some of the solution and polish it lightly with a block of Water of Ayr stone; then wash with water, and afterwards treat it with the nitric-alum wash as recommended in Chapter X. Wash off and dry. The stone will then be ready for the first transfer.

There is a special reason for this preliminary chemical treatment. It has the effect of hardening the surface and preventing the first transfer from getting deep into the stone. If this is neglected, the chances are that although subsequent transfers may be easily removed and will not attempt to return, the first transfer will be continually reappearing. To reprepare the stone for subsequent printings, the old work is treated exactly as described for the preliminary chemical treatment, that is, it should be polished slightly with the block of Water of Ayr stone and caustic solution, washed with pure water, then with the nitric-alum solution, and finally with pure water and dried.

Graining Stones.—When the stone is required for a direct crayon drawing, it is necessary for it to undergo the further process of graining. This is required to give it a texture, so that, when the artist draws upon it, the lines, instead of appearing like pen-and-ink lines, are broken up into minute dots, thus allowing him to produce any desired tone from a solid to

the finest tint. The graining is done by covering the stone with good flint sand or glass powder—coarse sand producing a coarse grain—and working over it in a regular, methodical manner with a small rounded stone of about 15 inches in circumference. The stone must be flat on the working side, and the edges, to avoid scratching, should be nicely rounded. A little water is sprinkled over the sand, and both hands (one on top of the other) placed upon the little rounded stone; then proceed, from the top left hand corner, in a manner describing small circles. The sand must be washed off and a fresh supply sifted on from time to time, and it must on no account be allowed to become much worn, or the result will be a flat grain. When the graining has been sufficiently carried out, the stone must be washed under running water with the aid of a clean, hard brush. It should then be allowed to dry, and examined by the artist who is to execute the drawing upon it.

The "Hansa" Automatic Stone-grinding Machine.—A useful machine that performs all of the above operations is the "Hansa" automatic stone-grinding machine, which is illustrated in Fig. 9. It grinds the stone and levels it at the same time; grains it for direct crayon drawings; or fine-polishes it for transfers. It is largely employed on the Continent.

On a strong base frame, the bed, there is a heavy table which glides in prism leads. This table supports the stone undergoing treatment. A cross piece extending over the table, which is fixed to the bed by means of lateral stands, supports the adjustable grinding head which is to be seen in Fig. 9.

The machine works in the following way. By means of the belt pulleys beside the bed, after the belts have been laid on, the motion is carried over the table through a cogged intermediate gear. In this way the table, together with the stone placed on it, is subjected to a movement in a longitudinal direction, and this motion is made a reciprocating one by the aid of reversing gear. The limit of travel of the table can be easily and quickly adjusted to requirements in each case while the machine is in full action. The grinding head is equipped with a special set of belt driving gear. The driving shaft, which is laid through the cross piece, transmits the motion to the head by means of a conical wheel mechanism, and at the same time acts upon the mechanism so that the grinding head becomes endowed with automatic motion. In the same way this movement is transformed into an automatic movement forwards and backwards by means of a slight adjustment by hand. The extent of the switch motion varies greatly according to the degree of adjustment employed in each individual case. The procedure employed in doing the grinding may therefore be briefly

summed up as follows: The table together with the stone is subjected to an automatic movement of a reciprocating character, and simultaneously a rotary movement of the grinding head takes place, during which the latter is steadily impelled in a forward direction in an automatic manner.

The whole of the requisite manual operations are to be performed from the quarter directly opposite to the belt gear, and that too at one and the same place.

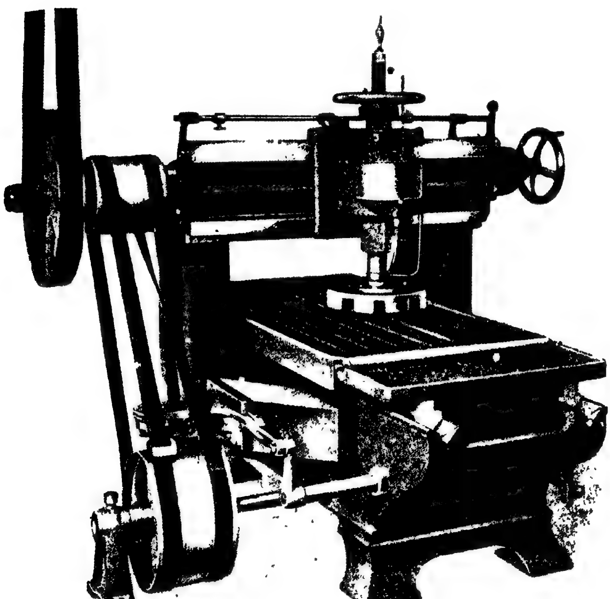


FIG. 9.—"Hansa" Automatic Stone-grinding Machine.

The "Hansa" machine may be equipped for direct electric power driving at an increased rate. The power of motor requisite is about 2-3 h.p., according to the size of machine employed. In this case the top intermediate gear is not required.

Thickness and Weight of Standard Sizes of Stones.—The following table shows the thickness and approximate weight of the standard sizes of lithographic stones. The names of the corresponding paper sizes are also given:—

Size. Inches.	Average Thickness. Inches.	Approximate Weight.	Corresponding Paper Sizes.
9 × 7	2¼	13 lbs.	Demy 8vo.
10 × 8	"	18 "	" "
11 × 9	"	22 "	" "
12 × 10	"	30 "	Imperial 8vo.
14 × 10	2½	35 "	Demy 4to.
15 × 11	"	40 "	Royal "
16 × 12	"	50 "	Crown Folio.
17 × 13	"	60 "	Large Post Folio.
18 × 12	"	60 "	Demy Folio.
18 × 14	2¾	70 "	Foolscap.
19 × 13	"	70 "	Demy Folio.
19 × 15	"	80 "	Foolscap.
20 × 14	"	80 "	Half Royal.
20 × 16	"	90 "	Crown.
21 × 15	"	90 "	"
22 × 14	"	90 "	Half Royal.
22 × 16	3	100 "	Crown.
22 × 18	"	110 "	Half Imperial.
23 × 17	"	110 "	" "
24 × 18	"	130 "	Demy.
25 × 19	"	150 "	"
26 × 20	3¼	165 "	Royal.
27 × 21	"	175 "	"
28 × 20	"	175 "	Elephant.
28 × 22	"	185 "	"
30 × 20	"	185 "	Double Crown.
30 × 22	"	200 "	" "
31 × 21	"	200 "	" "
32 × 22	3½	220 "	Imperial.
32 × 24	"	240 "	"
34 × 24	"	260 "	"
36 × 24	"	280 "	Double Demy.
36 × 26	"	300 "	" "
38 × 26	"	310 "	" "
38 × 28	"	330 "	" "
40 × 28	"	360 "	" Royal.
40 × 30	3¾	400 "	Quad Crown.
42 × 28	"	400 "	" "
42 × 32	"	440 "	" "
48 × 36	4	650 "	" Demy.
52 × 38	"	750 "	" Royal.
60 × 40	"	900 "	" Double Crown.
62 × 42	"	1000 "	" Imperial.

CHAPTER III.

ALUMINIUM AND ZINC PLATES.

Occurrence and Properties of Aluminium.—Aluminium is a light metal which does not occur native, but is widely distributed throughout the world as the oxide, alumina, and the silicate, clay. It is now extensively manufactured, chiefly by means of the intense heat obtainable in electric furnaces. It is a silver-white metal, rather bluish in comparison with pure silver. It is of equal hardness to the latter metal when cast, but becomes still harder when rolled, a process which also gives it the desirable quality of flexibility. It is capable of taking on a good polish, and is highly resonant. As compared with lithographic stone and zinc it is not so readily attacked by acids—nitric acid, for instance, having no effect upon it. It is, however, soluble in hydrochloric acid and dilute sulphuric acid; and it is acted upon by a solution of common salt when organic acids (acetic, citric, tartaric, etc.) are present. It is also readily soluble in caustic alkaline solutions. A particularly interesting reaction is set up if a solution of common salt, to which has been added 20 per cent nitrate of mercury, is applied to an aluminium plate and allowed to act for a few seconds and then wiped off with a dry cloth. Owing to the evolution of heat the part dries almost immediately, and there at once appears a growth of a white, woolly, crystalline substance, which if brushed off quickly repeats itself, and will do so several times until the action is exhausted. The plate will then be found upon examination to be covered at that part with minute holes.

Graining of Aluminium Plates.—For planographic printing purposes aluminium is rolled into sheets or plates of various thickness to suit the requirements of the different makes of machines. The rolling produces upon each side of the plate a hard, polished skin, which is not suited for lithography. This must therefore be removed from the working surface, and replaced by a granulated one, before work may be put upon the plate. The reason for this is that a polished lithographic stone, to a very large extent, is naturally absorbent of moisture and sensitive to the action of

the chemicals; but a polished metal plate is non-absorbent and is only slightly sensitive to the action of the chemicals. The granulating or roughening of the surface supplies the necessary qualities.

Plate-graining Machine.—The graining is done in a *plate-graining machine* (Fig. 10) which consists of a light, shallow trough or tray, resting upon four steel balls in a saucer-like arrangement—one at each corner of the iron framework support. The plate is placed face up on the bottom of the tray, and the whole area is covered with glass or porcelain marbles of about 1 inch diameter. When the machine is set in motion, these rotate in small confined spaces, cutting up the surface of the plate, with the aid

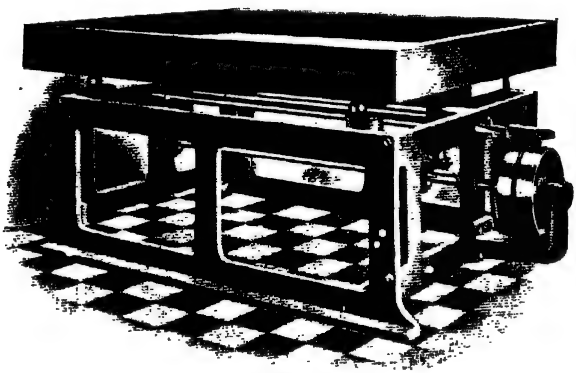


FIG. 10.—Plate-graining Machine.

of sand, glass, or pumice powder, and giving to it the appearance of ground glass—a coarse grain being obtained with coarse sand. It is necessary during the graining process to renew the sand or powder, which must be kept wet with pure water at frequent intervals, as already indicated in connection with the graining of lithographic stones; otherwise the grain becomes flat or worn, and the best results cannot afterwards be obtained.

A plate-graining trough should be fitted with a false bottom made in three pieces, from 1 to 2 inches thick. The centre piece must be the exact width of the printing surface of the plate cylinder of a rotary machine or the iron bed-plate of a flat-bed machine, so that the bent-over gripper edges of the plate fall neatly over the sides. The other two pieces then clamp them in-

and form a complete ground for the marbles to rotate upon. The clamping edges of this false bottom should be made to suit the angle of the bent-over edges of the plate.

Finishing Operations.—When the graining has been carried on for about an hour, the machine is stopped and the plate is immediately removed and washed. This is done by catching hold of the bent gripper edge of the plate, raising it slightly, and throwing off the marbles with a jerk, after which it is placed on the polishing trough face down upon clean paper, and the back washed. It is then turned over, and the face is treated in the same manner, using a large, soft Turkey sponge and plenty of pure running water. The plate must then be dried quickly with the aid of heat; otherwise it may oxidize so much as to be spoiled.

There is yet one more preliminary operation to perform before the plate is ready for the transferrer, and it is a very important one, although it is unnecessary if the plate has been grained for a direct crayon drawing. During the washing and drying of the plate a slight oxidation of the surface has taken place, and there may also be a certain amount of grit adhering here and there which the sponge has failed to remove, and which would cause the transfer to appear rotten or broken. To remove this, and ensure that the plate shall be otherwise clean and in good condition to receive the work, it is sprinkled over with some dry, crisp No. 0 pumice powder and rubbed lightly all over with a felt pad, in a manner describing small circles. Hard rubbing must be avoided. It is then thoroughly dusted with clean cotton wool.

Removal of Work from Plates.—To remove finished work from a plate, whether aluminium or zinc, it should be placed face up upon a litho stone or other support. Some coarse pumice powder is then sprinkled over the surface along with a little caustic soda solution, and the whole is rubbed with a wooden block (covered or otherwise) until the work has disappeared. It is then washed and treated as a new plate.

Occurrence and Properties of Zinc.—Zinc is a bluish-white metal, much heavier than aluminium, which is extracted from various naturally occurring ores, chiefly the sulphide (*zinc blende*) and the carbonate (*calamine*). It is easily soluble in hydrochloric, nitric, and sulphuric acids. It oxidizes but little in dry air, or in water free from air; but in a damp atmosphere it quickly becomes coated with basic carbonate.

Preparation of Zinc for Lithography.—For planographic printing purposes zinc is prepared in the graining trough exactly like aluminium, but owing to the very dark colour which it assumes, it is subjected after the washing to a chemical sensitizing

treatment which has a twofold object, namely, to whiten the plate so that fine work may the more readily be seen upon it, and also to render it more sensitive to the action of the fatty acids contained in the transfer inks.

Immediately after washing, and while the plate is still wet, it is flooded with a solution of a dilute corrosive acid, using for the purpose a large, soft Turkey sponge. After rinsing well under *pure* running water, and drying off quickly, it is finished by rubbing lightly all over with crisp No. 0 pumice powder as directed for aluminium, when it is ready to receive work. In selecting an acid for this purpose, one must be chosen that has a decided whitening action without depositing an adherent film, such as phosphoric acid would do. Nearly all the well-known acids in general use for repreparing and cleaning lithographic stone will give the required result on zinc. Acetic acid with alum is recommended in the following proportions: 2 oz. acetic acid, ½ oz. powdered alum, 60 oz. water.

Graining Metal Plates by Hand.—Graining zinc and aluminium plates by hand is not to be recommended. The time required to do the work is considerable and the results are not as satisfactory as those obtained with a power graining machine. For the purpose, however, a small tray may be made on similar lines to the power grainer, the marbles being kept in motion by shaking it about. A simpler way is to grain the plate exactly in the same manner as described for graining a lithographic stone.

The Relative Values of the Different Printing Surfaces.—In considering the relative values of stone, zinc, and aluminium as printing surfaces it is necessary to take into account the experience the transferrer has had, not only in connection with the particular surface about to be transferred upon, but also with the particular class of transfer in hand. Before the advent of the aluminium plate, plain uncoated zinc was not so well understood as it is at the present day, but fair and even good results were sometimes obtained from plates coated with calcareous preparations. These, however, are now but little used and are practically out of date. Many transferrers and machine men, having gained experience with aluminium, hesitate to make any change, while others who have had considerable experience with both metals declare in favour of zinc. There is one thing certain, however: work transferred to zinc will take a firmer hold than the same work would do on aluminium; and the former does not oxidize anything like so readily as the latter, which is a great consideration. Undoubtedly zinc is steadily gaining favour in the trade, while aluminium is just as steadily losing it.

Certain classes of work, such as a large sheetful of copper-plate transfers, are better done from stone, owing to the difficulty experienced in clearing away scum and scratches, and the disinclination of the hard plate transfer ink generally used for this purpose to transfer perfectly. Stones, of course, cannot be used on rotary machines and are therefore out of the question for economical printing; and they cannot be stored away by the hundred in a small cupboard or rack awaiting a repeat order of the job that at present occupies the surface. We may conclude then that under certain conditions, and with certain classes of transfers, stone is the most useful material, but generally speaking the metal plate possesses economical and other advantages over the former. There is also the question of cost. In the case of stone it is a matter of pounds, where with metal plates it is merely a matter of shillings.

CHAPTER IV.

CHEMICALS AND OTHER MATERIALS USED IN LITHOGRAPHY.

Chemical Notation.—In this chapter there is given in alphabetical order, chiefly for reference, an explanatory list of all the materials commonly used in connection with planographic printing. In many cases the chemical formula is given, and to make these formulæ intelligible to non-chemical readers the following explanations are necessary.

Each element is denoted in chemistry by a symbol. The following symbols occur in this list or elsewhere in the book: C = Carbon, H = Hydrogen, O = Oxygen, N = Nitrogen, P = Phosphorus, S = Sulphur, K = Potassium, Na = Sodium, Ca = Calcium, Mg = Magnesium, Al = Aluminium, Zn = Zinc, Pb = Lead, Cr = Chromium, Cl = Chlorine. Acetic acid is denoted by the formula $C_2H_4O_2$, which means that the molecule (or smallest ultimate constituent) of acetic acid is composed of 2 atoms (or smallest ultimate constituents) of carbon, 4 atoms of hydrogen, and 2 atoms of oxygen. So with other compounds. Several groups of elements occur very often in chemical formulæ. Of these a few may be noted here, namely, NH_4 = Ammonium (a kind of hypothetical metal which does not actually exist as an element), SO_4 = a sulphate, OH (or HO) = a hydrate, CO_3 = a carbonate, NO_3 = a nitrate, HPO_4 = a phosphate, H_2O = water.

LIST OF PLANOGRAPHIC MATERIALS.

Acetic Acid, $C_2H_4O_2$, is a colourless liquid, obtained from crude wood vinegar. It is used in a dilute form to reprepare a lithographic stone for additions and new work. The work should first be inked with a very sparingly charged black ink roller, and dusted over with resin. The diluted acid is then applied to the parts where the additions are to be made, and they are afterwards washed with clean warm water. It is also used in conjunction with alum to sensitize zinc plates after the graining has been completed and the plate washed.

Alum, $K_2SO_4 . Al_2(SO_4)_3 . 24\ H_2O$, is a double sulphate of aluminium and potassium. It dissolves easily in cold water if

previously powdered, and in this form, but very much diluted, it is used to make a lithographic stone more sensitive previous to laying down transfers of a weak nature, such as re-transfers containing delicate work or fine litho writing. It is also used in conjunction with acetic and other acids for the same purpose on zinc plates after the graining has been finished and the plates washed.

Ammonium Nitrate, NH_4NO_3, is a colourless crystalline substance similar in appearance to common salt. It is of bitter taste and readily soluble in water. It is used in lithography with other chemicals as a metal plate etch, but it is of little practical value.

Ammonium Phosphate, $(NH_4)_2HPO_4$, is a colourless crystalline substance like common salt in appearance and taste. It is used as a desensitizer (or etch) on zinc and aluminium, in conjunction with gum solution, phosphoric and other acids. It is also used in the damping water at the machine as an anti-tint solution: 1½ oz. ammonium phosphate dissolved in a little water and added to 80 oz. thin gum arabic solution. A cupful or less of this in a pail of water may be used continuously.

Asphalt. See **Gum Asphaltum** on page 26.

Beeswax is obtained from the honeycomb of bees, and is used in lithography as an ingredient in transfer inks, for waxing sewing thread, and as a protective film against damp on engraved steel plates. For the last-named purpose it is better to add to it, by heating, an equal proportion of paraffin wax.

Benzoline is a clear, colourless liquid obtained from coal tar. It is a solvent of fatty bodies and resinous gums, and is principally used for this purpose in lithography. It is very inflammable, and must be used with great caution.

Bichromate of Potash, $K_2Cr_2O_7$, is a hard, red, anhydrous crystalline substance very sensitive to the action of light, which makes it useful in photo-lithographic work. It is also used with gum solution on zinc. It should not be exposed to light for more than a few minutes. Its use is not recommended, as it is very caustic and poisonous.

Carbolic Acid or **Phenol**, C_6H_5OH, obtained from coal tar, is a powerful solvent of fatty bodies. It is useful for dissolving ink on a lithographic stone or zinc plate, when the ink has become hard and refuses to dissolve by ordinary means. It has strong antiseptic qualities, and if a few drops are added to paste, gum, etc., it will counteract putrefaction.

Castor Oil is used occasionally for softening the under side of leather tympans, but it should be employed sparingly. It is also used for the same purpose on the leather of machine buffers (air cushions); and the crude oil is useful for lubricat-

ing new machinery and for shafting which has been allowed to fire.

Caustic Potash or **Potassium Hydrate**, KOH, is a strong caustic alkali similar to caustic soda, and is used in lithography for the same purpose, but it is not as good as the latter.

Caustic Soda or **Sodium Hydrate**, NaOH, has the property of saponifying fats (that is, converting them into soaps) and rendering them easily soluble in water. It has a very corrosive effect upon the skin and should therefore be handled with great care. In lithography it may be used as a chemical stone polish; and also in conjunction with pumice powder for removing old work from zinc and aluminium plates previous to graining them in the plate-graining machine. Caustic soda readily dissolves aluminium, but apparently has little or no effect upon zinc or lithographic stone.

Chromic Acid, CrO_3, is obtained by the decomposition of bichromate of potash with concentrated sulphuric acid, and forms rhombic crystals which deliquesce when exposed to air. It is used in conjunction with other acids or salts as a desensitizer (or etch) for zinc or aluminium. If used with gum solution, it should be made up each time as required. It acts very injuriously upon the skin, and should be avoided by lithographers if possible.

Citric Acid, $C_6H_8O_7$, is obtained chiefly from the juice of lemons. It is used for the same purpose as acetic acid, and is much safer, as it does not form adherent crystals on the surface.

Crayons for lithographic purposes are made from a mixture of wax, soap, tallow, shellac, and lampblack, which are all boiled together. The mass is then cast into shapes resembling short pencils.

Cuttle-fish Bone is the internal calcareous plate of the cuttle-fish. It is sometimes used by lithographic artists for working up asphaltum tints on grained stones, and by the lithographer for improving impoverished work on stone. The stone should be gummed over and fanned dry, and the work washed out with turps and oil. The cuttle bone is then rubbed lightly over the work to expose a new surface to the action of the grease and asphaltum with which it is afterwards developed. This method of restoring work should not be attempted unless the design shows clearly in relief from the action of previous etchings.

Dabbers and Daubers.—A *dabber* is a small block of wood covered on the face with cloth or flannel and used for the purpose of inking-in engravings done on stone. A *dauber* may be described as a ball of soft cotton cloth used for the purpose of charging a transfer on stone or metal plate with ink previous to dusting it with resin and preparing it with an etching solution.

Damping Cloths are used by the transferrer and hand-press printer for distributing the damp in an even, uniform manner over the stone or plate. Any soft, open, cotton material will do. The coverings from the carcases of frozen meat, when washed, are excellent for this purpose.

Dextrine, Starch Gum, or **British Gum** is prepared from starch and is especially useful to the lithographic machineman for its strong adhesive qualities. The brown quality appears to be more adhesive than the white. Dextrine is also used by the lithographic artist for gumming-out air-brush work.

Flake White, or carbonate of lead, $PbCO_3$, is a pure form of the pigment white lead. It is used as a white ink when ground with litho varnish, and in transfer paper compositions when ground with water.

French Chalk or **Talc** is a hydrated magnesium silicate. It is used for dusting over the work to form an acid resist previous to etching ; but it should be dusted lightly, for if rubbed hard it is inclined to adhere to parts where it is not wanted, and so to prevent the acid from doing its work. It is also useful at the machine for dusting over the feed-board, cylinder covering, etc., and also for dusting over certain bright enamel and other papers when the ink refuses to bind firmly to them. In the last-mentioned case the dusting should be done a day or two after the printing.

Gelatine or **Glue** is obtained from the tissues and bones of animals and is employed in lithography chiefly for transfer paper coatings. Only the hard, clear, amber-coloured qualities should be used.

Glass Powder of various grades is used to roughen or grain zinc and aluminium plates. The coarse qualities may be used for grinding old work off lithographic stones.

Glycerine, $C_3H_5\,(OH)_3$, when pure, is a colourless liquid and very sweet to the taste. It is obtained as a by-product in the manufacture of soaps and fatty acids. It is very hygroscopic, and for that reason it is employed in the manufacture of ever-damp transfer papers. A small quantity may also be used in the damping water when printing from stone, for the purpose of keeping the stone moist with a minimum quantity of water. It must not, however, be used on metal plates, as it readily dissolves the oxides of many metals, and renders zinc and aluminium sensitive to the action of grease.

Gold Size is a drier of the varnish or terebene order, and is one of the best and safest for lithographic purposes.

Gum Arabic and **Gum Senegal** are the dried juice of several kinds of African acacia. There is little to distinguish between the two gums, and their properties are almost identi-

cal, as they are the product of the same trees, but from different countries. They are of great value to the lithographer, because of their chemical action upon stone and plate after the work has been put upon them, by reversing the conditions of those parts not containing work. Owing to the action of the arabic acid contained in the gum solution, the parts not containing work are rendered more or less ink-resisting and water-attracting. The gums are also used in powder form in the process of transposing or reversing work. To powder the gum the water which it contains must first be driven off by heating. It may then be easily powdered after it has assumed a white sugary appearance.

Gum Asphaltum or **Asphalt** is a mineral pitch of a blackish-brown colour and is soluble in benzoline and turpentine. It is used in the form of a thin varnish by applying a small quantity to the work, after the ink has first been removed with turps. The best quality comes from Trinidad, and this, after special treatment, becomes very sensitive to the action of light, when it is no longer soluble in turpentine. It is used in this form for photo reproductions in half-tone on zinc.

Gum Elemi is a resinous exudation from certain trees. It makes a good addition to transfer inks.

Gum Gamboge or **Gamboge** is a reddish-yellow gum resin obtained from a laurel-like tree in the Malay Peninsula, and is valuable chiefly for its deep yellow colour when dissolved in water, but it also has adhesive qualities. It is used in transfer paper coatings because of these properties, and it may be used by the litho writer to paint over errors or make alterations on the transfer paper. A fresh writing may be made on top of the old one when the solution has dried.

Hydrochloric Acid, HCl, is obtained as a by-product in the manufacture of salt cake. It is not used to any extent by lithographers, but is sometimes useful if applied to zinc or aluminium plates (when dry) for the purpose of keeping away dirt and work that has been cleaned off.

Indiarubber. See **Rubber** on page 29.

Lampblack, or oil soot, is obtained by burning oils. Sometimes this is done by burning the oil as in a lamp, that is, with a wick; or it may be burned without a wick. Metal cylinders which are kept cool from the inside revolve over the flames and the soot is removed with a knife-scraper. This substance is used in the manufacture of copperplate transfer ink, but is not used as much as formerly in the manufacture of printing ink.

Lavender Oil is an essential oil extracted from the lavender plant. The commercial quality is used in lithography for the purpose of easing printing inks, for, like other essential oils, it

does not affect their drying properties. It is also used in ink doctors, transfer inks, etc. It is not economical to use.

Linseed Oil.—Linseed oil is obtained from the seeds of the flax plant. For printing purposes the oil is produced by hot pressing. It is of a yellow colour, but turns brown when rancid. To decolorize it again, lithographic varnish makers expose it in open tanks to the action of sunlight. It is sometimes adulterated with cod and whale oils. Besides serving as a basis for the manufacture of litho varnishes, it is useful for thinning inks, and also for imparting to a stone engraving the property of a lithograph by enabling it to attract printing ink.

Litharge, PbO, is an oxide of lead which, when mixed with boiled linseed oil, may be used as a paste-drier.

Magnesia, or **Magnesium Carbonate**, $MgCO_3$, is sometimes added to stiffen printing inks which have been made too thin and are not working clean. It is also used to dust over printed work which is not drying quick enough.

Naphtha is a spirit distilled from shale. It is used for washing ink rollers, slabs, etc., but for this purpose it is better to be mixed with an equal portion of paraffin oil. It may be used in the pure state for cleaning damping rollers previous to washing and scraping them, as it evaporates very quickly. By the addition of a little oleic acid it makes a good "wash-out" for use on top of the dry gum on stone previous to applying the asphaltum solution. It may be used for most things in place of turpentine, than which it is a great deal cheaper, but it is not so good as the latter for dissolving gum asphaltum. A variety called *solvent naphtha* is considered best for washing rubber blankets.

Nitric Acid, HNO_3, is a powerful corrosive liquid requiring great care in handling. In its diluted form it is one of the most useful acids at the disposal of the lithographer. It is employed for etching or roughening the lithographic stone after the work has been put upon it; and it may also be used to clean parts for receiving new work or alterations. If applied to zinc or aluminium, alum should be added to the solution.

Offset Powder is a dust used for the purpose of making offsets, or faints, upon stone or plate as a guide for the artist to work to. The best is the indelible "Standphast" variety.

Oleic Acid or **Oleine**, $C_{18}H_{34}O_2$, is obtained by the saponification of linseed and other oils, and also as a by-product in the manufacture of stearine. It is a most powerful grease, and is invaluable to the lithographer. It may be used in printing ink (with care), and in turps or naphtha as a wash-out solution.

Oxalic Acid, $C_2H_2O_4$, is a colourless crystalline acid obtained by treating sawdust with nitric and sulphuric acids. In com-

bination with lithographic stone it forms oxalate of lime; and it is used by the machineman as a saturated solution which is applied to the edges of the stone for the purpose of preventing their taking ink. It does not act as a corrosive acid upon stone, but belongs to the class which adhere or "build up"; therefore, if by misadventure some of the solution has touched the work, and the part refuses to print, the adherent film must be removed by slightly polishing the part with a piece of polishing stone; the work is then rubbed up with an ink dabber and gum sponge and treated as a new transfer. This acid should be used very sparingly and cautiously. On aluminium it acts as a sensitizer. It is very poisonous.

Palm Oil is obtained by means of pressure from the fruit of the oil palm of West Africa. Used in lithographic printing ink as a doctor, it has the objectionable quality of causing scratches through the work by the particles of hard fatty acid which it often contains; and it is a non-drier.

Paraffin Oil, or **Mineral Oil,** is a thin, non-drying liquid distilled from shale. For washing ink slabs, rollers, etc., it should be mixed with an equal proportion of naphtha.

Paraffin Wax is obtained from the same source as the oil. The distillate separates after cooling in the filter presses, one part forming into wax. It is used in the manufacture of transfer inks, etc., and in conjunction with beeswax for protecting engraved steel plates.

Peasemeal.—Peasemeal is sometimes dusted over sheets to assist printed work to dry quickly. It may be improved for this purpose by the addition of a little French chalk. It is sometimes mixed with bronze powder, when the bronze has a tendency to blacken certain enamel papers or cards.

Phosphoric Acid, H_3PO_4, is a colourless syrupy liquid obtained by the decomposition of calcium phosphate with dilute sulphuric acid. It is the principal acid used in the preparation of transfers on zinc or aluminium plates, and forms upon them an adherent film of phosphate of zinc and phosphate of aluminium respectively. It may be used with or without the addition of gum solution, but the plate must be gummed over afterwards.

Pitch is one of the principal ingredients in copperplate transfer ink; and the kind generally used is the common black variety. It is obtained by heating wood tar until all the volatile constituents have passed off; when it becomes a hard resinous substance, easily affected by heat.

Plaster of Paris is a white chalky powder composed of several kinds of gypsum. It is used in the coating composition for plate transfer paper.

Potash, Caustic. See **Caustic Potash** on page 24.

Pumice Stone is a sponge-like substance found in the neighbourhood of volcanoes. It is used for polishing lithographic stones; but for this purpose the artificial briquette is better. It is used in the powdered form for graining zinc and aluminium plates, and also for roughening stones previous to transferring.

Resin, in the form of a fine powder called *flour resin*, is the chief acid resist of the lithographer. It is obtained by first dipping pine wood into alcohol, and then distilling the solution thus obtained. The residue is resin.

Rubber, Indiarubber, or **Caoutchouc** is the juice of various tropical trees. The juice, which is of a milky nature, is collected in a cup fixed below a hole drilled in the bark. The liquid is spread out thinly in clay vessels and dried in hot smoke. The impurities are then removed, and it is afterwards worked in a kneading and rolling machine. It is used in lithographic printing for covering the blanket cylinder on offset machines, and also for the expanding sheet on the enlarging and reducing machine. Indiarubber dissolves readily in carbon disulphide.

Sand is used to grind out old work from lithographic stone previous to repolishing it; also for graining either stones or metal plates when required by the artist for direct crayon drawings. For this latter purpose hard flint sand is perhaps the best; and this should be passed through a sieve that will give the proper grade to suit the work in hand. Other powders, such as glass and emery, may be used for the same purpose.

Shellac.—Shellac is a gum or resin produced in large quantities by the lac insect which thrives on the branches of several trees native to the East Indies. It contains a strong dye called lac dye. After the dye has been extracted, the residue is dried into cakes. If dissolved in spirits it forms the well-known spirit varnish. For cheap qualities the varnish is adulterated with resin. It is used as an ingredient in copper-plate transfer ink.

Soap is a substance composed of various fats and oils in combination with soda or potash. It is the addition of these alkalis that gives to the fats the quality of being soluble in water. Wax and resin also enter largely into the composition of soaps; and the different qualities also vary considerably in the percentage of water which they contain. It will thus be seen that, as an ingredient in transfer inks, soap is a very uncertain quantity. It should be cut into shavings and the water allowed to evaporate before it is used.

Soda, Caustic. See **Caustic Soda** on page 24.

Sodium Phosphate, Na_2HPO_4, like ammonium phos-

phate, is useful in conjunction with gum arabic solution, etc. as an etch for zinc and aluminium plates.

Sponges are indispensable to the lithographer, whether transferrer or machineman. Only the best Turkey qualities should be used, which are close in texture and very soft. Before wetting them, they should be well beaten with a hammer or other hard instrument, so that the small shells which they contain may be pulverized and afterwards dislodged by shaking; or they may be immersed for a short time in dilute nitric acid (vinegar strength).

Starch, $C_6H_{10}O_5$, is prepared from wheat, maize, rice, potatoes, etc. It is used in the manufacture of dextrine, and for direct lithographic purposes as an ingredient in transfer paper compositions.

Stearine, or **Stearic Acid**, is a hard, white substance made from dripping, tallow, palm, and other oils, which are subjected to pressure to remove the oleine or oleic acid. It is used by lithographic machinemen to restore weak work by rubbing a little on a soft cloth and applying it to the parts requiring to be strengthened.

Suet.—Suet is the fatty tissue situated in the regions of the loins and kidneys of the sheep and ox, and is useful in lithography as an ingredient in transfer inks owing to its melting and hardening qualities and also for the oleine which it contains.

Syrup.—Syrup is obtained as a by-product in the manufacture of sugar. It is of a sticky, semi-fluid consistency and possesses the quality of being hygroscopic, that is to say, it attracts moisture. It is useful in paste for sticking down transfers, and also as an ingredient in transfer paper compositions.

Tallow is the fat of oxen and sheep after having been freed from the cell walls, blood, and other impurities; and consists of over 70 per cent stearine and palmitine. It is used as a lubricant on the tympan of transferring presses, in the manufacture of transfer inks, and as a doctor in printing ink. For the last-named purpose, however, it must be borne in mind that it is an absolute non-drier; yet for this very reason a small quantity is often useful, especially in chrome yellows when they form the groundwork of a job in a number of workings, and in any other colour which is likely to prove too quick-drying, so preventing the succeeding colours from printing properly.

Tam o' Shanter Stone. See **Water of Ayr Stone** on page 31.

Terebene is a liquid drier prepared from turpentine and is useful in bronze work, as it is inclined to dry sticky. It should be used cautiously in colour work and on super-calendered papers.

Turps or **Oil of Turpentine** is a wood spirit, and is used in lithography as a solvent; also for washing out work on stone or plate, and for thinning down printing ink. It is also very useful as an aid in transferring facsimile writings which have been written on plain, uncoated paper. It is very penetrating, yet mild in action, non-greasy, and very volatile. The drawback to its more extensive use is its cost. Ordinary naphtha is pretty much of the same nature as turps and is very much cheaper.

Varnish (Litho) is the medium into which dry colours are ground to form printing ink. It is made by boiling linseed oil to various degrees of thickness, the grades being known as *extra thin*, *thin*, *medium*, *strong*, and *extra-strong.* Many of the cheaper lithographic varnishes are adulterated with resin to obtain the required degree of thickness without the expense of boiling. These never work satisfactorily and are deficient in drying qualities. Only the best Baltic linseed oil should be used in making litho varnish.

Vaseline is prepared from petroleum and is a good lubricant for certain parts of machinery. It may also be used in litho inks to cause them to sink, and to make them pasty, that is, to *shorten* them.

Water of Ayr Stone is a dark blue-grey slate-like stone of very fine texture, resembling the texture of lithographic stone, but slightly softer. It is used in large blocks for giving the final polish to the litho stone; and also in the form of pencils by the transferrer for cleaning purposes. The quality known as *Tam o' Shanter stone* is the most suitable for lithographic purposes. *Snake stone* is a similar stone used in the same way.

Whitening.—Whitening is chalk which has been pulverized and freed from impurities. It is sometimes used along with peasemeal and French chalk for dusting printed sheets upon which the ink is not drying quick enough. It is also used for polishing copper and steel plates previous to taking the transfer. Only the fine precipitated whitening should be used for lithographic purposes.

CHAPTER V.

DRAWING, PROVING, AND HAND-PRESS WORK.

Methods of Lithographic Drawing.—The original design or hand-coloured sketch is not necessarily the work of the lithographic artist, although he may often be called upon to make it, but he should always be consulted as to the number of workings that will be necessary to produce the desired effect. It is then his special business to analyse the work in his mind, and to translate his impressions in a lithographic manner to stone, metal plate, or transfer paper, the result being several drawings which, when printed in their respective colours one on top of the other, or *superimposed*, as it is called, will produce a facsimile of the original drawing. This he may do by different methods: (1) by *hand stippling*, or by using *shading mediums;* (2) by working with a *greasy crayon* upon a grained lithographic surface; (3) by *spraying* with the air-brush, or aerograph, or by *splashing* upon a polished stone or slightly roughened metal plate; (4) by working up *transfers having a photographic base*, half-tone, collotype, etc.; (5) by a combination of the above methods. Each method has its own special advantages.

Number of Printings.—The number of printings, and the method by which the work is to be carried out, must to a large extent be determined by the nature of the design and other circumstances. If the subject is a fully coloured one, with considerable detail in the drawing, the work of artist, transferrer, and printer alike will be much simpler when nine or ten printings are allowed than when only six or seven colours are to be used. The larger number of printings will include special workings for the light tints, which will therefore not require the same careful handling as when they have to be obtained by breaking up the strong colours into almost microscopic dots; but it is always to the advantage of the trade to produce the very best possible work in the fewest printings.

The Work of the Prover.—The proving room is the connecting link between the artist's department and the transferring room, and the prover is the person whose duty it is to supply the artist with offsets upon stone, metal plate, or transfer paper. It

is also his business, when the artist has finished the work, to desensitize the stone or plate and prepare it for printing, proving, or taking transfers, and also to carry out necessary alterations, with or without the guidance of the artist, as occasion may require. He should be a very competent lithographer, with a keen appreciation of colour, and a thorough knowledge of the chemistry of his trade. Much depends upon the prover, for if his work is not carried out in a thorough and efficient manner, the defects are often permanent, resulting in flat, poor, and muddy work. It is a quite common practice in the trade to supply a customer with a poorly printed proof of his job, in the belief that if the best work were sent out as proofs there might be difficulty afterwards in obtaining as good a result on the printing machine. This is a much mistaken policy, which often ends in the loss of the job altogether. The tools of the prover and transferrer are shown in Fig. 11.

Making a Key.—If the work which the artist is about to proceed with is an ordinary coloured sketch without an outline, then, as a temporary guide for his own use, and afterwards for that of the transferrer, an outline must be made. This is called the *key* (Fig. 12), and is made by pinning down a sheet of gelatine on top of the sketch and tracing the latter by scratching the gelatine with a steel point. This gelatine engraving is then handed over to the prover or the transferrer, to be filled in with soft transfer ink, which is done by dabbing the ink all over the sheet and working it into the engraving, then wiping away the superfluous ink with rags and whitening in a manner similar to inking a copper or steel plate. It must then be placed between damp sheets until the gelatine becomes quite limp, when it is run through the press a few times on a clean stone under a good pressure. It may then be pulled off. If the work has not transferred properly, it is because the gelatine has not been made sufficiently limp and yielding to allow of the close contact required between the ink and the stone; but it may again be placed between the damp sheets and the transferring repeated.

Guide Lines and Register Marks.—If the subject is a label or coloured outline drawing, the artist may proceed at once with the work, drawing the outline with lithographic writing ink upon transfer tracing paper placed over the sketch. He may add a few temporary *guide or key lines* to certain parts containing more than one colour, which are not enclosed, and these lines may be taken away when the work is being proved. The artist must not forget to put in the *register marks* (Fig. 12), which usually consist of not fewer than four crosses, one at either side, and one each at the top and the bottom, close to the work. The use of these will be explained later.

Offsets or **Faints.**—The offset or faint is a coloured impression of the key upon stone, metal plate, or transfer paper,

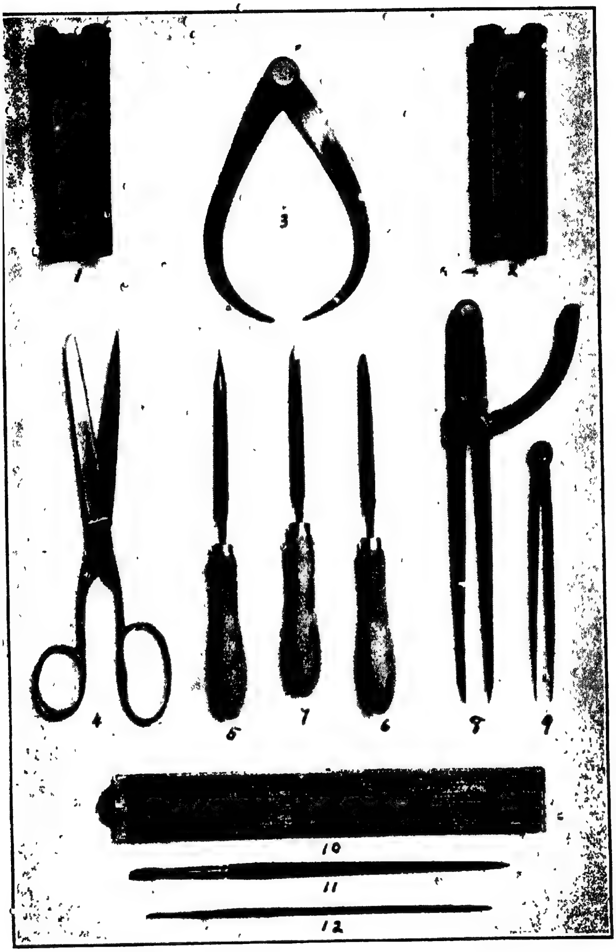


FIG. 11.—Prover's and Transferrer's Tools.

1, 2, Leather roller-handle covers. 3, Callipers. 4, Scissors (4½ inch blades). 5, 6, 7, Scrapers (5, point too long; 6, point too short; 7, medium point, correct). 8, Dividers. 9, Compasses. 10, Foot rule. 11. Camel-hair acid brush. 12, Sable-hair touching-up brush.

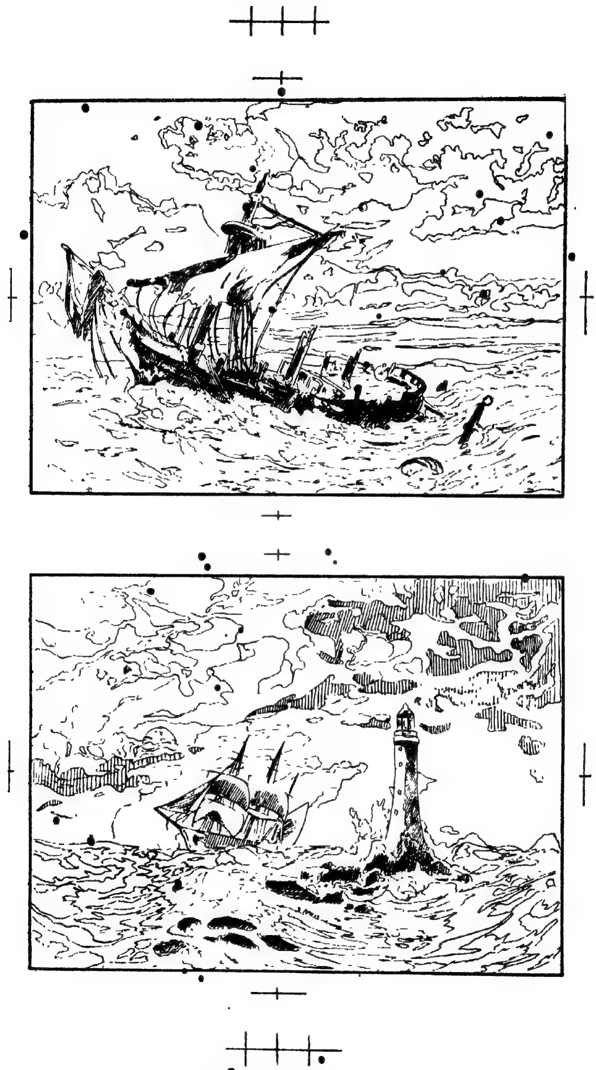


FIG. 12.—Key showing Prover's and Transferrer's Register Marks.

such colouring matter being used as will in no way affect the work, or take printing ink later when the stone or plate is being prepared. An impression of the key is printed in black ink on a suitable non-stretching paper and dusted over immediately with an *offset powder* while the ink is still wet. The best powders for this purpose are those specially prepared with aniline dye. The usual mode of applying the dust is to pour a sufficient quantity on to the printed sheet, after which the sheet is lifted by catching hold of either end, and the dust is worked about until it has travelled over all parts. Pour back the dust into the box, and then work some fine sand over the sheet in exactly the same manner. This will have the effect of removing the superfluous dust and clearing up the impression generally. One offset will be required for each colour to be drawn up.

Reversing the Key.—If the work is to be done upon grained transfer paper, the key impression, immediately after pulling, must be laid face down upon another piece of paper placed upon the stone and pulled through the press under pressure to reverse the image. The original impression may be discarded, and the reversed (offsetted) one dusted over with the offset powder, which is then laid upon the grained transfer paper and pulled through the press under a fair pressure in exactly the same manner as the offset impression. It is then ready for the artist to fill in the work.

Offsets or Faints for Offset Machine Work.—When the job is to be printed on the offset machine, the offsets must not be reversed for drawing on grained transfer paper; but they will have to be reversed if put to stone or metal plate. For offset machine printing, the work when on stone or plate must read the ordinary way (from left to right), but for direct printing it must read from right to left. The stone should be dampened before pulling through the offset, but for metal plates it must be put on dry. The impression should contain little more than a trace of ink; otherwise it will get through the powder on to the plate and act like a transfer.

Hand Stippling.—Hand stippling (Fig. 13) is a process of dotting with pen and lithographic writing ink, and is especially useful in modelling and working up gradations in small spaces, such as are required, for instance, when giving expression to the flush upon a child's cheeks. The dots are put in large and close together where the flush is strongest,

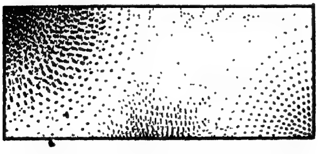


FIG. 13.—Illustration of Hand Stippling.

tapering off to a mere microscopic dot according to the strength of colour in which it is to be printed. Each dot is done with the utmost care, and one at a time.

Shading Mediums.—Stippling may also be done by using a mechanical device called a shading medium (Fig. 14). This consists of a thin, transparent, gelatine or celluloid casting from an intaglio (or sunk) plate of engraved dots, lines, etc., stretched across a frame. The dots, lines, etc. are in relief, and the film is charged with transfer ink by rolling it over with a letterpress printing roller (a small hand one). When the film is laid face down upon the stone or plate, the offset impression may easily be seen through it; and the artist, by rubbing the back of it at any particular part, will produce corresponding dots, lines, etc. upon the stone or plate by contact. These films may be had in a great many patterns, and are extremely useful for flat tints, sky effects, etc.

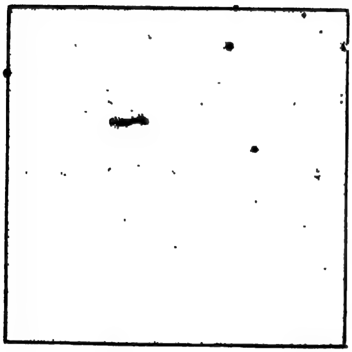


FIG. 14.—Shading Medium.

Finishing Stipple Work.—If the work has been executed by either of these methods, the stone or plate will most likely have been already gummed over by the artist; but if not, it must be gummed over now and fanned dry. The work is then treated as an ordinary transfer by rubbing it up with a black ink dabber and gum sponge, dusting with resin, etching, and cleaning up as recommended in Chapter X.

Crayon Work.—Crayon or chalk work calls for delicacy and refinement. Only the most experienced lithographic artists are capable of doing real justice to this class of work, and the same may also be said of those who come after them, the provers, transferrers, and printers. Copal crayons of different degrees of hardness are used in working up the drawing upon a specially grained stone or metal plate. If the work has been done upon stone, it must first be treated with an acidulated gum arabic solution. The gum should be of a thin, syrupy consistency, and nitric acid should be added to it until it produces a mild effervescence when applied to the edge of the stone. The work is etched at this stage in order to convert the soluble,

soapy crayon immediately into a substance which is insoluble in watery solutions, and also to desensitize the stone and allow greater freedom and certainty in the treatment which is to follow.

Treating Crayon Work on Stone.—To carry out this etching operation the stone should be placed upon a trough and the etching solution applied freely, but evenly, with a broad camel-hair brush. Allow the stone to remain undisturbed until the solution has dried, when it may be washed off with plenty of pure water, not forgetting to rinse the sponge well afterwards. Now pour upon the stone, while still damp, sufficient turpentine to wash out the work, using for the purpose a soft, clean cloth. When the crayon is all dissolved, sprinkle a little pure water in along with it, and with the aid of the cloth mix it all together. Wipe it down until the stone is just the right dampness for rolling; then ink in the work with a black ink roller which has been previously scraped and charged with a very little thin ink. The trace of turpentine still on the stone will cause a tint to follow the roller. It will enable the finest work to take ink at once and will also assist the solids and dark portions. After a few rollings all will come clear as the turpentine evaporates. When the work appears to be fully inked and presents all the life and sparkle which the artist intended it to have, it must be dusted over with resin, cleaned up, and etched again; washed off, dried, and gummed up.

Treating Crayon Work on Metal Plates.—If the work has been drawn upon a grained zinc or aluminium plate, the treatment will differ considerably from that done on the grained stone. In the first place nitric acid cannot be used as an etching solution upon zinc, and it will be found more difficult to convert the soluble crayon to an insoluble condition, but the following method may be safely adopted. Dissolve ¼ oz. ammonium phosphate in a little water, and add this to half a pint of gum arabic solution of medium consistency; then with the broad camel-hair brush apply the solution to the plate. Do not go over any part twice if it has been sufficiently coated with the first application. Now take a sheet of soft printing paper, lay it on top of the plate so covered with wet solution, and pass the hand quickly all over it. Take the sheet off at once, and along with it as much of the solution as possible. Repeat this with clean sheets until no more solution can be taken up, when the plate must be fanned dry,[1] and the work washed out on top

[1] The reader will come across the words "fanned dry" or "fan dry" many times in this book, and therefore a short explanation may be useful. A piece of cardboard or something similar is used to hasten the drying of a damp surface, by being shaken backwards and forwards rapidly across the surface in a fan-like manner.

of the dry solution by the asphaltum method, as recommended in Chapter X. The work is then charged with ink by inking in with a black ink roller which has been previously scraped, and to which a few drops of turps may be added as required to assist the inking. When the work appears to be fully charged, dust it over with resin, and then with French chalk; clean away the dirt, desensitize the plate with the regular plate-etching solution, and then gum up. The most satisfactory etch for this purpose is Arobene, which does the two operations (etching and gumming) in one. The dirt should be cleaned away with a piece of pointed wood wetted with caustic soda solution and a touch of pumice powder; or if fairly strong hydrochloric acid is carefully applied to the parts while the plate is *dry* there will be little risk of the dirt reappearing. The scraper and polishing stone must not be used on metal.

Aerograph or Air-brush Work (The New Lithography).—Aerograph work, and especially retransferred aerograph work, is generally considered in the trade as impracticable, and at present there are only one or two firms in the country that have really made a commercial success of the process; and yet the whole matter is simplicity itself, and the most delightful results may be obtained, and long editions printed from one transfer if a few simple rules are put into practice. The process is most useful in working up large spaces, and for tints which taper away from the solid to a mere microscopic dot. For calendars, large book illustrations, show cards, posters, etc., and imitation water-colour drawings on thick, soft, matt paper (which should be printed slightly damp), the process is hard to beat for beautiful results and economy in working up.

The Air-brush.—The air-brush (Fig. 15) is a small instru-

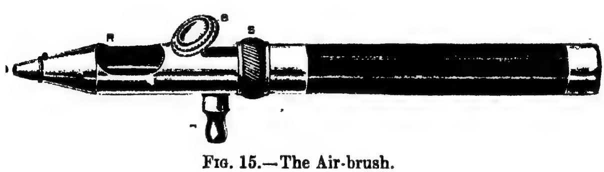


FIG. 15.—The Air-brush.

ment, resembling a fountain pen in appearance. It does the work by blowing out a fine spray of ink by means of compressed air. To the brush is attached a rubber tube which is connected at the other end to the compressed air-tank. The pump may be worked by foot (but this is not recommended) or it may be driven by power, with an automatic arrangement for

switching on and off the belt according to the pressure indicated on the air-pressure gauge (Fig. 16).

The size of dot may be regulated by pressure of the fore-finger, which rests upon a small lever arrangement about the centre of the brush. This makes it suitable for any class of work. The work may be printed direct from the original on stone, zinc, or aluminium; but, strange to say, the best work is printed from transfers on zinc plate, at high speed in rotary machines. Fig. 17 is an illustration of air-brush work.

The Process.—For work which is intended to be retransferred, *stones only* should be used as originals. Let these be of good quality and nicely polished. After setting the stone in

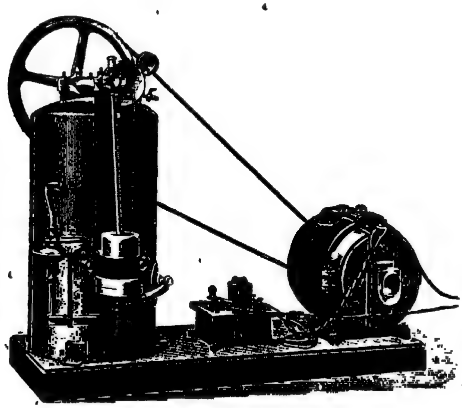


FIG. 16.—Compressed-air Tank and Motor Drive.

the press and fixing the pressure, dampen it with clean water, and while it is still slightly wet, run down the offset, which should be strong and bold. The offset powder must be the indelible "Standphast" variety. Allow the stone to remain undisturbed for at least half an hour before proceeding, the offset requiring this time to penetrate the stone and become more or less permanent, and also to withstand the subsequent treatment. Now it must be understood that in this case the transfer ink is not applied to the stone by rubbing, or by pressure, or by painting with a brush, but by a process of allowing a fine spray, blown from a delicate instrument, to settle upon it almost as dust from the atmosphere would settle; and it will be quite apparent that the slightest trace of foreign matter on the face of the stone in any form whatever, will absolutely prevent this

dusty spray from attaching itself and becoming sound work. It will, upon reflection, also suggest itself, that during the gumming-out by the artist trouble will be in store if anything but the most harmless of substances is used for this purpose; so it will be necessary to make a slight departure from the ordinary lithographic routine and adopt only methods suitable for this special process.

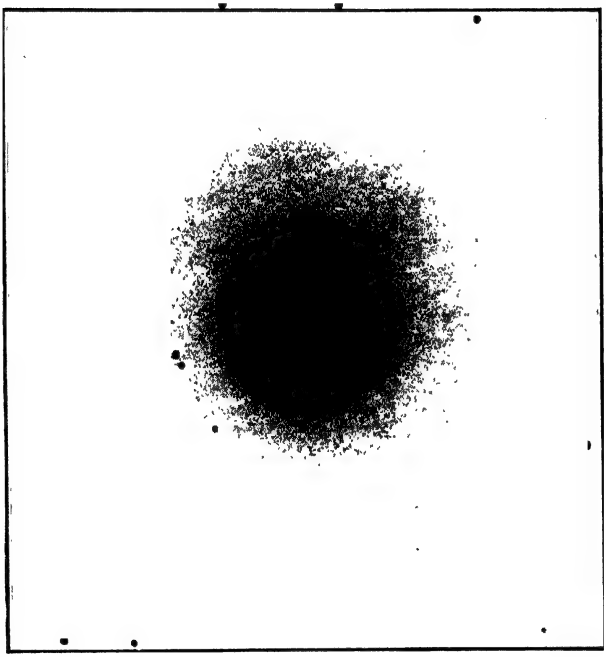


FIG. 17.—Air-brush Work.

Preparing the Stone for the Work.—Place the stone with the offset upon it on a trough, and flood it with pure water from the hose pipe, but do not touch it with cloth or sponge. While it is in this condition, pour over it from a porcelain jug or other porcelain vessel a quantity of nitric acid solution (diluted with pure water only, with no alum or other sensitizer) of sufficient strength to produce a brisk effervescence. The stone being wet, the acid

will flow evenly. When the effervescence has ceased, flood it again with plenty of pure water from the hose pipe, and then stand it on end to dry. On no account should any sponge or other article be used at this stage to assist in drying the stone, or streaks through the work will be the result. When the stone is thoroughly dry it is ready for the artist. The acid treatment of the stone will have in no way affected the offset impression.

Gumming-out or Stopping-out.—Stopping-out is a means of protecting those parts of the work which are considered as being finished, or parts of the stone which are to be kept free of the spray altogether. When a sufficient quantity of spray has been blown on to suit the very lightest tints,[1] these parts are gummed over and the spraying continued and then further gumming-out done, and so on. Ordinary gum arabic solution must *not* be used for this purpose, as the work will not stand its biting tendency. Take equal parts of brown and white dextrine powders, mix these with water to an ordinary gum consistency, then heat to boiling point. Add a small quantity of dry vermilionette powder as colouring matter, and a few drops of carbolic acid to prevent it turning sour. It may be used when cold, and will remain fresh and sweet for a considerable time if bottled. It should be applied liberally, because, if too thin, the ink from subsequent spraying may go through it. When the artist has completed the work, he should gum over all remaining parts with dextrine solution as well as the parts already gummed out, for the purpose of redissolving that which has dried. Then take up all the superfluous gum solution by laying on a piece of paper and passing the hand over it quickly, repeating this with clean paper until all has been absorbed; then fan dry. The work may remain in this condition until the prover is ready to take it over. The artist usually removes the cap altogether from the nozzle of the brush, and it is sometimes necessary here to increase the aperture somewhat to facilitate the flow of the thickish litho ink, and also to give a more decided lithographic texture. This is effected by rubbing the nozzle on an oil stone—care being taken not to overdo it.

Preparing the Stone for Proving, Printing, or for Transfers.—When the stone leaves the artist it will be found to be coated—as already explained—with a thin, even film of dextrine, which should *not* be removed with water. Pour upon the stone a little freshly made gum arabic solution, and distribute this evenly with a soft, clean sponge and fan dry. This will remove the dextrine, and prepare the stone for inking. When the gum has been dried, wash it off with clean water, and ink-in

[1] A special dense black liquid litho writing ink at present on the market is best for aerographic work.

the work with a black-ink hand roller which has been previously scraped and very sparingly charged with thinnish black ink. It will now be found that owing to the preliminary etching which the stone received after the offsets were put on, the work takes the ink perfectly, and there is no inclination of the stone to tint, or of the half tones and three-quarter tones to thicken; in fact the work appears exactly as the artist put it on—the first step towards perfect results. When the work is considered to be sufficiently charged with ink, dust it over with the finest flour resin, and afterwards with French chalk, and then etch evenly with a solution of gum arabic and nitric acid of sufficient strength to produce a mild effervescence. Then gum-up and fan dry. The work should always be washed out with asphaltum solution on top of a thin film of dry gum. The best transfers are obtained on the ever-damp or semi-moist varieties of transfer papers, and the stone which is to receive the transfer may be first sensitized with a little weak alum solution, and the work charged with ink by the rubbing-up method as recommended in Chapter X. As already explained, zinc is the best printing surface for this class of transfer.

Splash Work.—This is a means of obtaining an irregular flat tint similar to that produced by the aerograph, but much coarser and more irregular. It is effected by dipping a tooth or similar brush into lithographic writing ink and then going over the tips of the hairs with some such instrument as the small blade of a pocket-knife in such a way as to cause the hairs to spring smartly forward. The splashes thus thrown produce a tint.

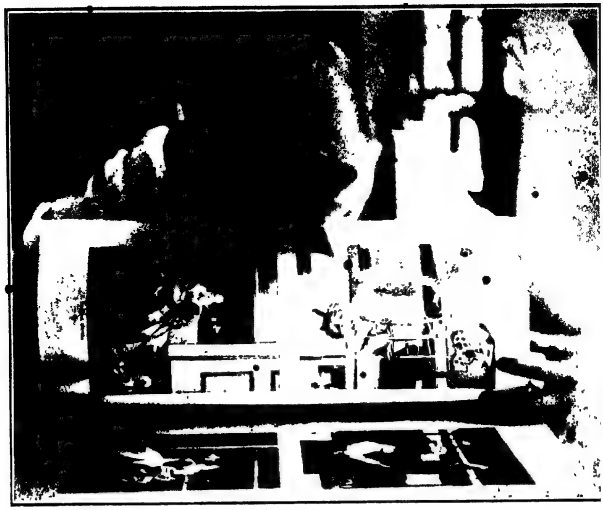
Photo-chromolithography.—Photo-chromolithography, or chromolithography with a photographic base, may be carried out in three or more colours by photographing the subject through a half-tone screen and printing it on light-sensitive zinc or aluminium, using for the purpose an orthochromatic plate, which is best for giving the true colour values. A number of transfers, according to the number of printings intended for the job, should be taken, some of which may be pulled sharp and others full. The artist will then select those he wishes for the different colours, which are afterwards transferred to stones, rubbed up very sparingly with thin black ink, and dusted over with resin. The artist may then polish or otherwise take out any parts that are not required; after which the stone must be etched with a very weak solution of nitric acid (no gum) to clean and sensitize it. It is then washed with pure water and dried, when it is ready for additional work. As soon as the artist has finished, gum over the stone and fan it dry; ink-in with a black ink roller, dust with resin, etch, and gum-up. The register

marks must be put on the original before starting to take the transfers. The same process may be applied to collotype transfers.

Proving Chromo-lithographic Work.—In proving chromo-lithographic work it is usual to do the yellow first, unless a bronze is to be employed, when it is generally made the first printing. The reason for doing the yellow at this early stage is that it is of a very dense, opaque nature, and would be likely to smother other colours if they were printed below. When there are a number of printings in the job, and the proving is likely to be extended over several days, a small piece of tallow or other non-drying fat should be added to the yellow ink, as the colours which are to follow will not print upon it nicely if it has been allowed to dry too hard.

How to Ensure Perfect Register.—Having done a sufficient number of proofs from the first printing, take a sharp needle (kept for this purpose) and point a hole through the centre of the register marks—which should be about one inch from either end of the sheet—and then lay the sheets face downwards for the next colour. Two more needles of the same size and thickness as that used for pointing the holes in the register marks are required for inserting into the holes just made, and then into corresponding holes in the stone or plate, when the work is being proved. The needles should be the ordinary fine sewing kind, inserted into small wooden handles about two inches long by a quarter of an inch square. The one to be used for piercing should be inserted in the wood eye first; and the other two point first. Then with the aid of a pair of pliers the latter two should be broken just above the eyes, and the parts rubbed on an oil stone to produce a short stumpy point in place of the long, tapering eyes. When these points are inserted into the register holes in the stone or plate, the needles will be of a uniform thickness all over; so it will make no difference whether the sheet is at the top of them—as it must be at this particular moment—or whether it is lying on the stone or plate previous to withdrawing them. There will be no play whatever between them and the holes in the stone or plate, and those in the proof sheet; thus ensuring perfect register. The holes in the stone or plate should be drilled with a sharp picker, exactly in the centre of the register marks, and only deep enough to take in the short stumpy points of the needles.

Having inked-in the work and inserted the needles in the proof sheet, handle it by placing the fingers underneath, so that the palms are up and the needles come through between the two inside fingers—the thumbs resting on top of the little two-inch handles to steady them (see Fig. 18). Now, with the fore-



First Position.

Second Position.

Fig. 18.—Registering Colour Work by means of Needles.

fingers bend the outer edge of the sheet over towards the body, so that when you are standing in a perfectly easy position the point-holes in the stone may be seen by looking over the top of the proof, not under it. When the needles have been inserted, and are in correct position, withdraw the fingers from below the proof, and place them in exactly the same position on top—still keeping the thumbs on the handles—and gently push it down on to the stone or plate. If necessary the needles may be inclined in one direction or another to suit any slight variation that may be taking place in the register, but otherwise they should be kept perfectly straight. While the sheet is being held firmly to the stone by the tips of the fingers, allow the needles to drop. Pick them up with the right hand just before taking off the left. Repeat the method with all succeeding colours.

Prevention of Offsetting.—When the colours are being followed in quick succession, trouble may arise from the offsetting upon the stone of the previously printed work, in which case the stone or plate must be kept damp while the proof is being pulled through. If the work is on stone, a little glycerine may be kept in the damping water, which will help considerably; but this substance must not be used upon metal plates, as its chemical action causes them to become greasy and take on tint. Sometimes the better way out of the difficulty is to dust over the proofs with magnesia, Paris whitening, French chalk, or peasemeal, or a mixture of them; but dusting always has the effect of dulling the colours slightly. As each colour stone or plate is finished, the work should be washed out, inked-in with a black ink roller, very sparingly charged, dusted over with resin, and gummed with clean gum.

Hand-press Printing.

Business Cards, Invoices, etc.—The hand-press (Fig. 19) is now seldom used for commercial work, but there are still a few shops where a little is done. The principal work done in this way consists of business cards, visiting cards, dance programmes, wedding invitations, and funeral letters, with occasionally a small order of note headings, invoices, or memorandum forms. The former are usually transferred to the stone with a slight twist, that is, not square with the stone, so that when they are pulled through under pressure the scraper will mount them first at the corners. This does not cause the stone to jerk, with the liability of the cards shifting, as would be the case if the scraper mounted them broadside. A number of various cards are transferred and printed together on the same

stone. The lay of each card is marked off on the stone, while it is damp, with a piece of compositor's lead which has been sharpened by scraping with a knife. A number of cards are then taken in the right hand and fanned or spread out so that the bottom card, as it is laid to the marks, may be easily steadied and held in position by the forefinger and thumb of the left hand. The cards should be slightly bent before laying them down, in order to prevent them from moving and also to keep

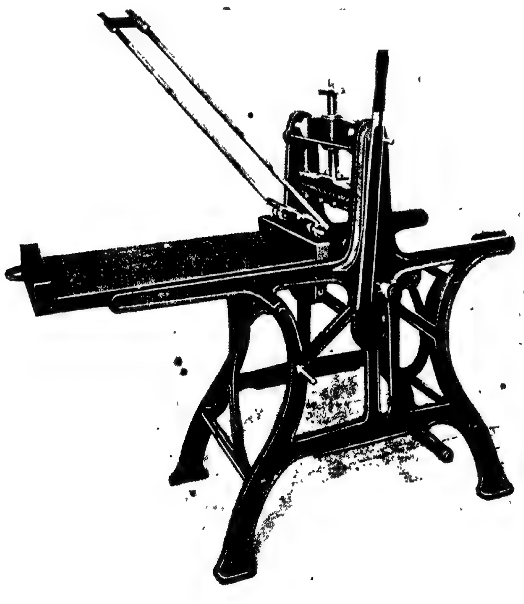


FIG. 19.—The Hand-press.

them from touching the work before the pressure is applied. Note headings, if printed with a fly-leaf, that is, with two leaves or four pages, should be transferred head to head with sufficient space between the sheets to admit of handling. Single note headings, invoices, and memorandum forms may be transferred several in a row, that is, one above the other the long way of the stone, allowing just a little more space between them than the depth of the work. The sheets are laid down commencing at the bottom one, the next overlapping the bottom one, and so on.

India Paper Prints.—Portraits and views printed on India paper and mounted simultaneously are produced in the following manner. The mounts, which should consist of a thick soft-sized paper, are first damped by lifting six or eight sheets of the paper and passing all together through a trough of pure water. As each lot is damped it is put on top of the previous lot and the whole allowed to stand for a short time, when weights may be put on them. It is better then to distribute the damp somewhat by halving the pile and then forming a new pile by taking alternately a small quantity from each. The paper should then be put into a screw or hydraulic press, or several stones put on the top of it, and pressed. The India paper must now be sponged over with thin, well-strained paste and hung over ropes to dry, after which it is cut to size and inserted sheet by sheet between the damp mounts. The lay of the India paper is next marked off with lead on the damp stone (a lead mark does not take ink if made while the printing surface is damp) and then the position or lay of the mount is likewise found and marked off. After the work has been inked in, the India paper is first laid down, taking care to have the pasted side uppermost, and then the mount on top, also taking care to note that the coarse side or back of the paper is uppermost. The tympan sheet is then laid on top, and the whole is pulled through under a firm pressure. The India paper will be found to be adhering firmly to the mount.

CHAPTER VI.

TRANSFER PAPERS AND INKS.

Kinds of Transfers.—A lithographic transfer is a print, writing, or drawing, done on a specially prepared paper, and with a special ink. Any number of such prints may be made and arranged in position upon sheets of paper of a suitable size for printing, and thereafter transferred to the printing surface from which the work is to be done. The prints may be taken from work already on stone or metal plate (planographic); or from engraved copper or steel plates (intaglio); or from engraved letterpress blocks and type (relief); or from collotype (planographic); or they may be printed upon light-sensitive transfer paper by photography. Whatever process they are produced by, the principle is the same, namely that of securing the image in an ink impregnated with fatty acids upon a paper coated with a medium that will readily dissolve in water after the means have been applied to ensure the necessary close contact between the ink and the printing surface to which the work is being transferred. There is yet another form of transfer, the litho-writing and crayon-drawing transfer.

Varieties of Transfer Papers.—A suitable transfer paper is necessary for each of the above-named processes, and they are known by the following names: Stone-to-stone or stone-to-plate transfer paper, which include the Scottish, Berlin, French, Semi-moist, and Ever-damp transfer papers; Copperplate transfer paper; Letterpress-to-stone transfer paper; Photo-litho transfer paper; Litho-writing and Grained transfer papers.

Stone-to-stone and Stone-to-plate Transfer Papers.—Stone-to-stone or stone-to-plate transfer paper should be of such a nature as will take a good print with a fair body of ink without spreading. It should be composed of materials that will not absorb or dry the ink, but rather tend to keep it unaffected upon the surface. It should be sufficiently adhesive to stick to a slightly dampened stone or plate during the first run through the press under a moderate pressure. It must be readily soluble in warm water.

Scottish Transfer Paper.—Scottish transfer paper has a similar composition to copperplate transfer paper, but it contains

more of the adhesive and ink-resisting element than the latter. It is considered useful when transfers from both stone and copperplate are to be patched up on one sheet, being then made adhesive by the very uncertain process of damping the whole together between damp sheets previous to transferring to a warm stone; or it may be transferred to a cold damp stone. Scottish paper will take a better impression if previously slightly dampened.

Berlin Transfer Paper.—Berlin transfer paper belongs to the bright-enamel variety, and apparently contains no glycerine or other hygroscopic agent, or only a very little. It takes an impression readily under a medium pressure; but owing to its glazed surface it is only capable of lifting a very thin film of ink without spreading, which seems to be its principal fault. It should be transferred to a damp surface.

French Transfer Paper.—French transfer paper is of the transparent order, which makes it especially useful for colour work where the register marks have been omitted by the artist. It is a dry transfer paper, and the composition with which it is coated apparently contains a large proportion of gum arabic. It takes a moderately good impression, but not all that could be desired, having the same fault as the Berlin paper. It gives considerable trouble at times from curling, especially during warm, dry weather; but this difficulty may be got over by sponging the backs of the sheets with water containing a little glycerine, and then hanging them over a rope to dry. This also improves the printing quality of the paper.

Semi-moist and Ever-damp Transfer Papers.—The nature of these is indicated by their titles, the latter being made damper than the former. The advantage of a damp paper in printing is that it picks up the ink better than a dry one. Damp paper is more yielding under pressure, and therefore comes into much closer contact with the printing surface. A damp transfer paper has this quality in its favour, but it has also others. The transfer ink is kept upon the surface of the composition instead of being absorbed, as in some cases, and the paper will readily adhere to a dry or slightly dampened stone or plate during the first run through the press under a moderate pressure. The disadvantages of damp papers are that they are subject to variations according to weather conditions, and also to risk of distortion of the transfer; but the transferrer will soon learn to guard against these difficulties. In the first place, the transfer paper must be protected, and the transfers should be kept in books made of blotting or antique wove papers; and secondly, the transfer must be taken off the work by pulling the paper uniformly, not from one corner. The

grain of the paper must also be studied, as it will stretch more in one direction than the other. This may be tested by tearing a strip from the sheet. It will tear easily and fairly straight in the direction the fibres run, the stretch taking place the opposite way. Undoubtedly, for all kinds of re-transfer work, whether colour or black, the moist papers rank first.

Copperplate Transfer Paper.—Copperplate transfer paper, as already explained, is of a similar nature to Scottish transfer paper, but the composition should contain less of the adhesive element than the latter, because of the amount of damping, heating, and pressure to which the paper is subjected during the operation of taking the transfer impression. If the composition contains too much paste and glue, great difficulty will be experienced in preventing the paper from sticking to the plate and refusing to leave it; but if, on the other hand, it contains insufficient quantities of these materials, it will be inclined to chip and leave the composition in the engraving instead of lifting out the ink; and there will also be difficulty in getting the paper to adhere to the stone or plate during the transferring, especially during the first run through the press under pressure, which is most essential.

The paper generally used for this purpose is an ordinary soft-sized printing paper of about 24 lb. demy (i.e. 24 lb. weight in the ream of demy size) which, when twice coated, as all copperplate transfer papers should be, makes a very thick, springy paper that can only be used with any degree of safety by first damping the transfer between sheets of damp paper until they become limp and adhesive. For small commercial jobs this method is quite good, but for large sheets of transfers the damping-book method is open to many objections. It is much better to use a thin paper, say 18 lb. (or less) demy, and transfer the work to a cold dampened stone or plate. Semi-moist transfer paper may also be used for this purpose, but the ink must be of a softer quality, and a sheet of thin rubber should be used as a backer.

Letterpress-to-stone (or Metal Plate) Transfer Paper.—The essential qualities of this paper are as follows. It must be very evenly coated, especially when it is to be used for transfers from half-tone cuts. It must be capable of taking a print equal to that of enamel paper. It must not absorb the ink, but should be of such a nature as to be capable of retaining it upon the surface in a fresh condition for an indefinite time. It must be capable of adhering firmly to a slightly dampened stone or plate during the first run through the press under pressure. The paper should be a hard-sized, super-calendered one, of good quality and stout firm body.

Photo-litho Transfer Paper.—Photo-litho transfer paper is prepared with a light-sensitive gelatinous coating, and is suited for line subjects; but the process is now, to a great extent, superseded by direct photo-printing on zinc or aluminium plates, which gives a much more satisfactory result in either line or half-tone. *An ordinary "Bank post" paper makes a suitable base for the transfer composition.*

Litho-writing Transfer Paper.—Litho-writing transfer paper should be made in two qualities, one for use on ordinary work, which need only be once coated, and the other for heavy plan work, which should be twice coated with a composition that may easily be scraped to admit of alterations and corrections, and still leave a sufficient amount of coating for transferring purposes. In either case the composition must be sufficiently hard to allow the writer or draughtsman to work freely upon it without clogging the pen; and it must have the quality necessary to enable it to stick to a slightly dampened cold stone or metal plate with the first run through the press under pressure.

Grained Transfer Paper.—Grained transfer paper is specially prepared to take the place of grained stones, and is useful as an easy means of transport if the drawings are made some distance away; but grained metal plates will give better results if treated properly, and they are just as easy to parcel up and post as the paper is. With plates, too, no transferring is required, but the artist is under the disadvantage of drawing the work from right to left instead of the correct way. The paper selected for graining should be a thick, soft-sized one, and should be thickly coated with a composition of the chalk or flake white order, which must contain, however, a sufficient quantity of adhesive material to enable the paper to stick to a dampened stone or plate during the first run through the press under pressure. The grain is given to the paper by first damping it (after coating) and then pulling it through a copperplate press on a specially engraved plate, in a manner similar to that of taking a copperplate transfer, but without ink; or a sharply grained stone or metal plate will do. It is ready for use when dry.

Materials for Coating Transfer Papers.—The table on the opposite page shows some of the materials used in the manufacture of lithographic transfer coatings, indicating the purposes for which each is added.

The *flour* is used in the form of paste, which is made as follows. To 1 lb. flour add 1 pint of cold water; mix this, and beat up with the hand until it is free from lumps; then add other 5 pints water. Place this on a fire or stove, and stir all the time till it boils; then lift the pot on to the floor or bench and continue stirring until it cools somewhat, when the lid should

Materials.	Thickening.	Adhesive.	Hygroscopic.	Colouring.
Flour	X	X	—	—
Starch	X	X	—	—
Glue	—	X	—	—
Flake White	X	—	—	—
Plaster of Paris	X	—	—	—
Gum Arabic	--	X	X	—
Syrup	X	X	X	—
Glycerine	—	—	X	—
Gum Gamboge	—	X	—	X

be placed on to prevent a skin from forming if it is not to be used at once.

The *starch* is also used in the form of paste, which is made by mixing it first with cold water, and then adding boiling water until it becomes clear and of the right consistency.

The *glue* should be allowed to soak for some hours in cold water. The water is then poured off, and the vessel containing the glue should be put into another vessel of a larger size containing hot or boiling water until dissolved. It may then be added to the other ingredients.

The *flake white* should be mixed with water into a stiff paste with a palette knife on a slab. It is then taken, little by little, and well ground with a muller, after which it is ready to add to the other articles.

Plaster of Paris is one of the most "tricky" articles the lithographer is asked to handle, and it is probably for this reason, and because of the lack of knowledge regarding substitutes, that so few shops make their own transfer papers; and that, where they are made, the quality is often so very poor. The old method of placing the plaster in a vessel, and repeatedly adding quantities of water until it showed no further signs of thickening, should not be followed. What usually happens to the beginner by following this method is, that when the mixture shows signs of requiring more water—which takes place very suddenly—it often gets into the solid or gritty condition before the necessary addition can be made, and then of course it is spoiled. Surely a given quantity of water can be absorbed by a given amount of plaster and mixed in a simple, practical manner.

Have two pails, one containing six measured pints of water, and the other thoroughly dry. Into the dry pail place 1 lb. plaster of Paris, and add to it from the other pail half a pint (a 10 oz. tumblerful) of the water. Mix this, using the hand, with the plaster quickly but thoroughly, until free of lumps; then without hesitation add the whole of the remaining water.

Swirl it round a few times with the hand, and then pour it off slowly into the pail which previously contained the water. This will get rid of the coarse particles, which by this time will have fallen to the bottom and may be washed out. The mixture must be stirred until it thickens, which will happen in about fifteen minutes. The success of the operation depends entirely upon the speed with which the first mixing is carried out.

The *gum arabic* should be dissolved in a given quantity of water, and then strained through a cloth of cotton or fine muslin.

Syrup (*golden*) may be used as bought.

Glycerine is also used as bought.

Gum gamboge should be bought in the powder form and mixed into a paste with cold water. It may then be added to the composition.

Recipes for Transfer Paper Coatings.

I. Scottish Transfer Paper.—

1 lb. flour made into paste with 6 pints of water.
1 lb. plaster of Paris prepared with 6 pints of water.
3 oz. glue.
2 oz. gum arabic dissolved in 8 oz. of water.
1 oz. gum gamboge.
40 drops carbolic acid.

For coating use a six-inch broad camel-hair brush, finishing off by using only the tips of the hair, which will prevent streaks. The composition should be kept warm while in use.

II. Semi-moist and Ever-damp Transfer Papers.—

1 lb. glue (best clear) soaked in
130 oz. water (more or less according to the quality of the glue).
30 oz. glycerine (pure).
40 drops carbolic acid.

Allow the glue to soak for twelve hours or longer. Then stand the vessel inside another containing very hot water. When the glue has melted, add the other ingredients. The paper, which should be a hard-sized, super-calendered one, should first be sponged on the back with a solution of two parts water to one part glycerine, and then pressed to flatten it. The composition should be used at a temperature of about 130° F. employing a six-inch broad camel-hair brush, finishing off with the tips of the hair as recommended in the previous recipe. More or less glycerine may be added, according to local requirements and conditions. What may suit one shop is unsuitable

in another. One point should be remembered in using glycerine: the larger the quantity used the sooner the composition will lose its adhesive quality and become useless. Hot water should be used in soaking off the transfers.

III. **Copperplate Transfer Paper.**—

1 lb. flour made into paste with 6 pints of water.
4 oz. starch made into paste.
1 lb. plaster of Paris prepared with 6 pints of water.
1 lb. flake white ground into paste.
1 oz. glue, soaked, and then melted.
2 oz. gum arabic dissolved in 8 oz. of water.
2 oz. gum gamboge (powder).
40 drops carbolic acid.

The composition should be kept warm, not hot, while in use, and should be measured with a spoon, giving the same quantity to each sheet. It should be worked well into the paper, brushing both ways, finishing with just the tip of the hair to smooth out the streaks. After the first coat has dried, the paper should be flattened by rolling it the reverse way of the curl, and then pressing it under weights. It should then receive a second coat; but this time it must be done by simply taking a quantity on the brush and distributing it very quickly over the sheet before the first coating has time to dissolve. This paper will remain good for years.

IV. **Letterpress-to-stone Transfer Paper.**—Prepare exactly as for semi-moist transfer paper, but it must be coated dry, not sponged first, and a considerably stouter paper should be used.

V. **Photo-litho Transfer Paper** (W. K. Burton).—Coat the paper with a simple solution of 10-per-cent gelatine. After this has set, it should be immersed for ten minutes in a saturated solution of alum, and then washed in cold water and dried. It then receives the following light-sensitive coating, of course, in a dark room:—

1½ oz. Nelson's No. 1 gelatine.
½ oz. white loaf sugar.
40 grains bichromate of potassium (converted into double chromate of potassium by the addition of ammonia).
1 pint water.

VI. **Writing Transfer Paper.**—

No. 1 (*Ordinary*).—

4 oz. gelatine, soaked in cold water before melting.
1 oz. gamboge powder, mixed in 4 oz. of cold water.

2 oz. plaster of Paris.
4 oz. flour paste.
2½ pints water (50 oz.).

No. 2 (for plan work, etc.).—
5 oz. gelatine.
4 oz. plaster of Paris.
4 oz. flake white.
1 oz. gamboge powder mixed in 4 oz. of cold water.
1½ oz. glycerine.
1 lb. flour paste (stiff).
12 oz. water.

The mixtures should be strained through a suitable cloth, and kept up to a moderate heat while in use. Apply with a 6-inch broad camel-hair brush. Both papers must be plate-glazed when dry. No. 2 must be twice coated.

VII. **Grained Transfer Paper.**—
1 lb. flour.
1 lb. plaster of Paris.
½ lb. flake white.
¼ lb. starch.

The composition must be kept warm while in use, and applied with a stiff-hair brush, finishing off with the usual broad camel-hair brush to prevent its drying streaky. The paper is usually coated twice, but one thick coating, if nicely finished with the fine brush, is sufficient.

Materials Used in Making Transfer Inks.—The following is a list of some of the materials used in the manufacture of lithographic transfer inks, showing the special use of each material:—

Materials.	Melting and Re-hardening.	Fatty Acid.	Printing Quality.	Colouring.
Soap	X	X	—	—
Suet	X	X	X	—
Beeswax	X	X	X	—
Paraffin Wax	X	—	—	—
Stearic Acid (Stearine)	—	X	—	—
Oleic Acid (Oleine)	—	X	—	—
Litho Varnish	—	X	X	—
Pitch	X	—	—	X
Shellac	X	—	—	—
Gum Asphaltum	X	—	—	—
Gum Elemi	X	—	X	—
Lampblack	—	—	—	X

Recipes for Transfer Inks.

I. **Stone-to-stone Transfer Ink.**—
½ lb. mutton suet.
½ lb. pitch (black).
¼ lb. soap.
1 lb. black litho ink.

First melt the suet, then add the pitch, followed by the soap, and finally the black ink.

II. **Copper and Steel Plate Transfer Ink** (an old recipe).—
½ lb. paraffin wax.
¼ lb. soap.
¼ lb. shellac.
½ lb. pitch.
½ lb. mutton suet.
½ lb. Venice turpentine.
1 oz. lampblack.

The suet and wax are first melted in an iron saucepan; then the soap is added in small quantities at a time to prevent tumefaction. The pitch, suet, and Venice turpentine may then be added, and finally the lampblack. These proportions may be altered somewhat to suit the requirements of a soft, hard, or extra hard ink, and the burning—which is to follow—may be prolonged a little if the ink is required harder. When the ingredients have all been added, the temperature is increased until the mixture takes fire when the surface is touched with a red-hot iron. It should then be allowed to burn from one to two minutes, when the lid of the pot is put on to extinguish the flame. It may then be poured on to a slab and divided into pieces of suitable size.

III. **Litho-writing Transfer Ink** (Lemercier).—
¼ lb. wax.
¼ lb. shellac.
¼ lb. suet.
¼ lb. soap.
1 oz. lampblack.

It is made exactly as given in the recipe for copperplate ink.

IV. **Letterpress-to-stone Transfer Ink.**

This ink may be made exactly like stone-to-stone transfer ink, but it may contain in addition a little oleic or stearic acid. It may also be used by the lithographic artist for shading mediums.

CHAPTER VII.

TRANSFERS.

Transfer Impressions.—Transfer impressions from stone or metal plates are taken in exactly the same manner as ordinary prints are taken upon ordinary paper, but essential features of transfers are the excellence of the impression and the presence of a sufficient amount of fatty acid in the ink. An ink suitable for this purpose may be made by adding a little oleic or stearic acid to ordinary slow-drying black (litho) printing ink, but it is better to prepare it according to a good recipe (see Chapter VI) or to buy it from a reliable manufacturer. It *must* contain, however, a sufficient quantity of the fatty acid to form an oleate with the stone or plate, but the amount must necessarily be limited; otherwise considerable trouble would be experienced through the tinting or greasing of the stone or metal plate from which the transfers were being taken. In all cases, the person taking the transfers should be provided with a *proof copy* in black ink of the work in hand as a guide to go by; and the transfer should be, if possible, a shade sharper and clearer than the proof. This condition may have to be brought about by a slight etching of the work before commencing. When the transfers have all been taken, roll up the work with a very bare black-ink roller, dust it over with resin, and gum an impression of the job on the face of the stone. It is better first to dampen the impression to prevent air blisters.

Copperplate Press and Accessories.—The copperplate press used in taking transfers is a very simple machine of the mangle type (Fig. 20). It consists of a framework support, two iron rollers, between which a travelling iron plank operates, and a handle or star wheel for pulling the plank through. The rollers are adjustable by means of pressure screws to suit the varying thicknesses of the copper plates. A *hot stove* or *heater* (Fig. 21); a *jigger* (Fig. 22), or box to hold whitening, which may also be used for wiping and polishing the plates upon; three or four fine printer's blankets; a few dusters; and a piece of copperplate ink will complete the outfit.

Copper and Steel Plate Transfers.—The taking of

transfers from a copper or steel plate engraving is a purely mechanical operation, and very similar in detail to ordinary

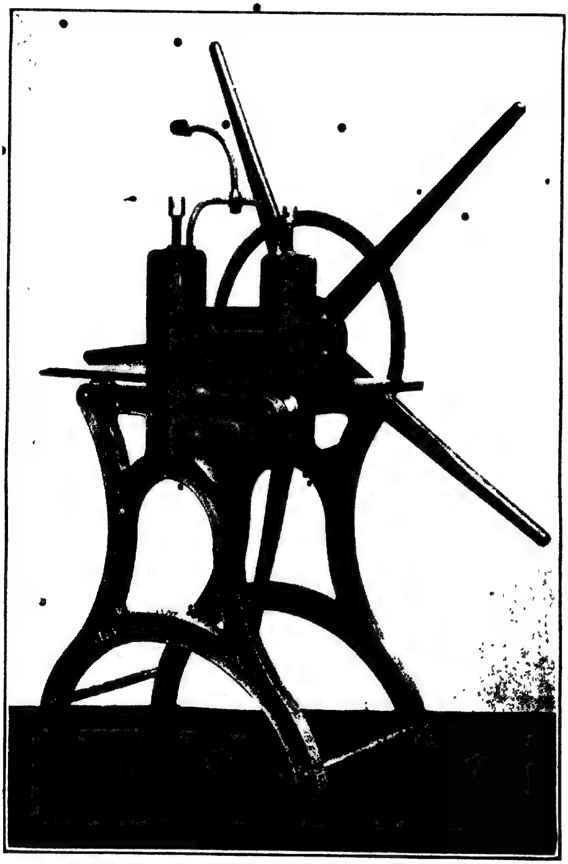


FIG. 20.—Copperplate Press.

copperplate printing, the principal differences being that in transfer work a harder ink and a coated paper are used, and that the transfer paper must be released from the plate by a process of heating.

Testing for Pressure.—If the plate is an old one, the engraving should first be cleaned out with a mixture of turps and carbolic acid, to rid it of all traces of old ink which may have been left in it, and then tested for pressure. As these plates vary considerably in thickness, care must be taken not to cut the blankets by risking too much. Place the plate in position on the iron bed and cover it with a piece of thin printing paper a little larger than the plate; then lay the blankets on top. If the plate appears to be a thickish one, discard one of the three or four blankets temporarily, and then pull the whole through the press—once only. If the pressure is right, it will be found upon examining the piece of paper that it now contains a complete embossed impression of the engraving, and that the edges of the plate have also left a uniform impression; but if the relief appears more pronounced on the one side than the other, the pressure screws must be adjusted to suit. In that

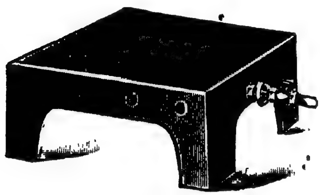


Fig. 21.—Hot Stove.

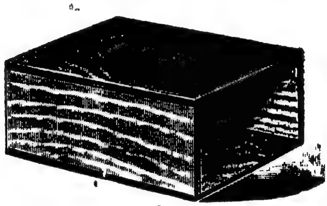


Fig. 22.—Jigger.

case release the screw on the side showing most pressure and then add the discarded blanket if necessary.

Inking-over and Pulling the Transfer.—Now place the plate on the hot stove or heater, and rub the transfer ink all over it. The heat will cause the ink to filter gradually through the cloth in which it should have been previously tied. It is not necessary that the plate should be very thickly coated. Having smeared it all over with the melted ink, it should be taken off the stove, and the ink should be worked into the engraving (on top of the jigger) with a cotton cloth in the form of a pad, giving it a firm twisting motion from the wrist in a manner describing semicircles. When the whole has been gone over, change the motion, without turning the cloth, to one of wiping, and continue this until all trace of the ink has been cleaned off. Then allow the plate to become thoroughly cold. There will still remain, however, a faint tint of ink all over the plate, and this must be polished away with a soft cotton cloth containing a little whitening. The plate is then gently warmed

all over, the dampened transfer paper is laid in position, and on top of this the blanket covering. The whole is then pulled through the press three or four times.

Quality of Paper.—The amount of damp required in the transfer paper will depend almost entirely upon the quality of the paper and the nature of the composition. A soft, thin paper with a composition containing too much of the adhesive element may give rise to considerable trouble by refusing to leave the plate if any more than the slightest amount of uniform damping is given to it; whilst, on the other hand, a hard thickish paper containing too little of the adhesive quality may leave the plate too quickly, refusing to pick up the ink properly, even though it has received a considerable amount of damping. In warming off the transfer, care should be taken not to over-heat the plate in places, or thickening of the work in these parts will be the result.

Offsetting Copperplate Transfers.—These transfers have yet to undergo a process of *offsetting*, which is a means of reducing the amount of ink that stands out in relief upon the transfer, thereby lessening the risk of the work *smashing*, or spreading under pressure during transferring. The offsetting is carried out by passing the transfer through the transferring press on top of a stone under a moderate pressure, face down upon blotting or other soft paper. If the blotting paper, with the transfer still adhering to it, is now held in front of a fire or stove, the transfer ink will soften, and the action of the heat will cause the transfer to curl off and leave some of the ink behind. This has sometimes to be repeated several times, according to the depth of the engraving and the manner in which the inking and heating of the plate has been carried out. This is one of the many weak points in the copperplate process; and the only advantage to be gained by engraving upon copper for litho purposes instead of on lithographic stone is that of storage.

Effect of Unequal Damping.—If the transfer is not uniformly glossy, but contains dull patches here and there, with an indication of the work being weak on these parts, it is due to unequal damping. The dull parts have not received sufficient water.

A Quicker Process for Copper and Steel Plate Transfers.—Transfers may also be taken from copper and steel plate engravings by placing them inside a frame of strawboard and pulling them through on top of a stone on an ordinary lithographic transferring press, using stone-to-stone transfer ink and paper. The transfer paper may be either the Scottish or the ever-damp variety, but if the former is used it must first be dampened, though not enough to make it stick to the plate.

First warm the plate, and then smear the engraving with the transfer ink (full strength), using for the purpose a firm cloth pad, and afterwards wipe it down with a cloth until only a uniform tint is left. Now rub a little whitening on the fleshy part of the hand, and by means of a few swift strokes towards the body—using more whitening if necessary—wipe the plate clean. The transfer paper is now laid on, and next to it a piece of rubber blanket or thin sheet rubber, and the whole is pulled through the press—once only. This process is quicker than the old method, and gives very satisfactory results after a little experience has been gained.

Advantages of Stone Engraving.—Transfer impressions from stone engravings are taken in quite a different manner to those from copper or steel plates. An engraving upon a lithographic stone is not only an engraving in the true sense of the term, but it has also the property of a lithograph, that is, it possesses the power of attracting greasy printing ink where it is required, and repelling it from all other parts by a water-retaining and ink-resisting surface. It will readily be understood, then, that such a process must possess immense advantages over a roundabout method such as that necessary for copperplate work. The stone process also excels in another respect, namely *depth of engraving*. Owing to the engraving on stone possessing the ink-attracting property, it is not necessary—nor would it be an advantage—to engrave so deeply as is required for copper or steel. This saves the trouble that arises from the ink standing out in relief and the subsequent necessary offsetting operation.

Decline of Stone Engraving in Britain.—The art of engraving upon a lithographic stone, and taking transfer impressions therefrom, has become almost lost in Britain, and the younger men in the trade know very little concerning it. The result is that commercial lithography, the branch of the trade for which stone engraving is so eminently suited, has sunk to such a low ebb that many people would rather have their work printed in plain type than accept the fearful "smudge" produced by many of the lithographic houses. This is not as it should be. Lithography is capable of reproducing the most beautiful effects in either black or colour, crayon or air-brush, stipple or line, but rules must be observed and laws obeyed.

American Commercial Stone Work.—It may not be generally known that nearly the whole of the fine specimens of American commercial work, which from time to time come over to Britain, are printed from transfers taken from engravings done on lithographic stone, and not from copper or steel plates. We on this side of the Atlantic have done our best to imitate this desirable class of work, and would undoubtedly have succeeded but for

the fact that we have so persistently adhered to that elaborate and uncertain process which has almost proved the ruin of this branch of our business.

Preparing a Stone for Engraving on.—The method of preparing a lithographic stone for engraving upon is as follows. Select one a little larger than the work which is to go on it. It should be of the hard grey quality and about three inches in thickness. Have it well ground and polished, and then subject it to rubbing with a pad and oxalic acid solution, and afterwards with a coat of gum, which should be fanned dry. The gum is then washed off under running water and the stone is fanned dry. It is then rubbed all over with a little lampblack powder, after which it is ready for the engraver. A stone-engraving machine is shown in Fig. 23. The engraving having been

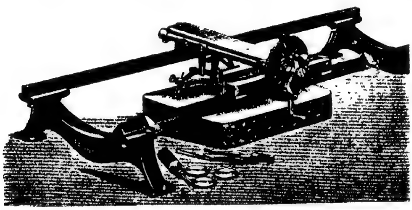


FIG. 23.—Stone-engraving Machine.

completed, the surface of the stone is next flooded with raw linseed oil, which should be allowed to remain on for a few minutes. The fatty acid contained in the oil will attack the engraved parts and will give them the property of attracting greasy printing ink. The oil may now be wiped away with a soft cloth, and the surface which has not been attacked by the oil, due to the protective film formed by the oxalic acid and gum, may be gummed over with clean, fresh gum and fanned dry.

Inking-in the Engraving.—The next part of the process is the inking-in of the engraving. Two dabbers (Fig. 24) are required for this purpose, one covered with thick, coarse printer's blanket, and the other with a thin fine quality. These coverings are stretched over pieces of wood about 4 in. square by 2 in. thick, and tacked round the sides. The transfer ink should be mixed with an equal quantity of

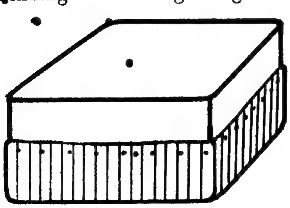


FIG. 24.—Dabber.

black ink and reduced with thin varnish. It should be used

stiff and spare on the fine dabber, and thinner and fuller on the coarse one. After washing the gum from the stone it is wiped over with the damping cloth, and the coarse dabber applied with a twisting motion, using as much pressure from the wrists as possible. The stone is then dampened again, and the fine dabber used in a similar manner, but finished off with a few light skiffs, which will have the effect of clearing the stone and sharpening the work. If clogging of the work takes place, or the stone takes ink on parts where it is not required, it is because the ink is too thin or there is too much of it on the dabber.

Pulling the Transfer.—The transfer paper, which should be of the soft, ever-damp variety, is now laid on the work, and on top of this a piece of thin sheet rubber, and then the card backer or tympan sheet (generally used with a leather tympan to protect the articles below from grease or dirt); then pull through the press under a fair pressure. A little gum should be kept in the damping water, as this helps to prevent scratches appearing on the transfers. An old dabber is better than a new one; but to get a new one into condition quickly, work it about over a coarse-grained stone along with a little thin black ink, lifting it off the rough surface straight up. Then with a lighted taper singe off the short hairs from the surface and repeat the operation, when it will be ready for use. After a little experience a good many perfect transfers may be taken in the time that would be required to pull one from a copper or steel plate.

When the transfers have all been taken, charge the engraving with ink, using the dabber, and dust it over with resin. Then gum an impression of the work over the face of the stone for the purpose of protecting the work, and also to serve as a ready means of identifying it. The impression should first be dampened to prevent air blisters, which often cause serious injury to lithographic work.

Photo-litho Transfers.—Photo-litho transfers are made by exposing the special gelatinous light-sensitive transfer paper to the action of light, under a strong, dense negative. After the exposure has been made, the print is taken from the frame (in the dark room) and charged with a very thin film of transfer ink. This is usually done by rolling the face of the print all over with a printer's ink roller (a small composition one). Then, after having received a thin uniform film of the transfer ink, it is put into cold water to soak. The gelatine which has not been acted upon by light will at once begin to absorb water, and will gradually lessen its hold of the ink; but on the parts where the conditions have been altered by the action of light, the water will have no effect and the ink will retain its hold.

When the transfer has had sufficient soaking, it is laid upon

a glass or stone slab, and the face is rubbed all over with wetted cotton wool. It will then be found that the ink will come away easily from all parts except where it is held by the work. It will now be readily understood that if the negative were thin and weak, allowing the light to penetrate, even though only a little, great difficulty would be experienced in obtaining a satisfactory result.

CHAPTER VIII.

PATCHING OR IMPOSITION OF THE TRANSFERS.

Introductory.—Having obtained the necessary number of transfers, the next proceeding is to place them in position upon a specially ruled-off sheet of the paper upon which the work is to be printed, a process known as *patching*. Owing to the multifarious nature of lithographic work generally, it is quite impossible in a book such as this to give anything more than a few brief hints in connection with this part of lithography. The patcher must be guided, to a very large extent, by the requirements of the particular work in hand, and by his natural common sense. There are a few rules, however, which are applicable to nearly all classes of work, such as the following: (1) Make certain that the size of sheet is correct before commencing to space it out; (2) make the proper allowance for gripping, i.e. leave a sufficient portion of the sheet, not to be printed on, for the machine to catch hold of; (3) make sure that the sheet is square; (4) mark the position and cutting lines which enable the printer to obtain at once the correct position of the work on the sheet without trouble, and which will also indicate to the cutter the exact places at which to cut the work; (5) mark off the position for the "point" dots for the folding machine, and for labels to be cut with a die; (6) attend to the correct imposition of the pages. All these rules call for more or less consideration at the proper time.

Gripper Allowance.—With letter headings, memorandum forms, catalogues, and other classes of book work, gripper room does not require to be considered, as the work does not come near to the edge of the paper; but in labels and many other classes of work, where a tint very often extends to the cutting line, an extra margin for gripper must be allowed for.

Testing the Lay-out Sheet.—Having secured a sheet of the paper upon which the work is about to be printed, measure it carefully in order to see whether it is the correct size, as the different reams sometimes vary considerably. If the work has been set up to an extra large sheet, the necessity sometimes arises for doing it all over again when the printer comes to a lot that has been cut a little under the standard size. It is safer,

therefore, to make the *lay-out sheet*, as it is called, slightly under the ordered size. If the nature of the work necessitates an extra allowance for gripper, then rule off a line with a HHH pencil lengthwise, not less than a quarter of an inch from the edge of the paper, and divide up the remainder of the sheet to suit the work, not forgetting to take the cutting into account.

As paper from the ream cannot be depended upon for squareness any more than for being correct in size, a set-square[1] must be laid exactly to a line drawn along the gripper edge of the sheet (the actual edge is often curved), and an upright line drawn either in the centre or at the side-lay end (the right-hand side), after which the sheet may be divided and ruled off the short way of the paper.

Imposition of the Pages.—If the sheet about to be ruled is for a booklet, or for a sixteen-page section of a book, it would mean that the whole of the sixteen pages would be printed together upon one side of the paper; after which it would be turned and the same matter printed on the reverse side, making two complete sets of sixteen pages each, or thirty-two pages in all. To find the correct imposition of the pages, it will be necessary to fold a sheet of the paper and page-number or folio it. The leaves, however, must not be cut separate, but only at the corners to permit of marking on the folio numbers. The sheet, as we have already seen, contains thirty-two pages; so it must be cut in half. Lay one half upon the bench as in the first diagram of Fig. 25, and fold it over as in dia. 2. Then fold a second time as in dia. 3, and a third time as shown in dia. 4.

If we now look at the folded sheet as it lies upon the bench, it will be seen that the page next to the bench has not been moved during the process of folding; and if we examine it still more closely, we shall find that all four corners of the sheet have been brought together. The page lying next to the bench constitutes the first page of the booklet or section. The four open corners should always be at the front whether it is to be a sixteen or a thirty-two page section. If a thirty-two page section is wanted, an important alteration takes place in folding, commencing at the third fold. Instead of the right-hand end of the sheet $^{x}_{x}$ (see dia. 3) being brought over to fold on top of $^{o}_{o}$, it is folded underneath so that $^{o}_{o}$ is on top of $^{x}_{x}$ (see dia. 5). There remains one more fold to convert this

[1] A lithographer need never be in want of a good set-square, as a reliable one may be made by simply folding a sheet of paper in half, and then folding it again to quarter size, bringing the first two folded edges exactly together. The folded edges represent the square.

rom sixteen to thirty-two pages. This is done by bringing lown the top to meet the bottom, but the fold must be made exactly as the last one, i.e. the top portion folded underneath the bottom, not on top (see dia. 6). With these two latter olds, a practical folder would turn over the sheet each time, and then fold as directed for sixteen pages.

The Margins.—The margins of a book are generally decided upon either by the author or the publisher; but this is not always

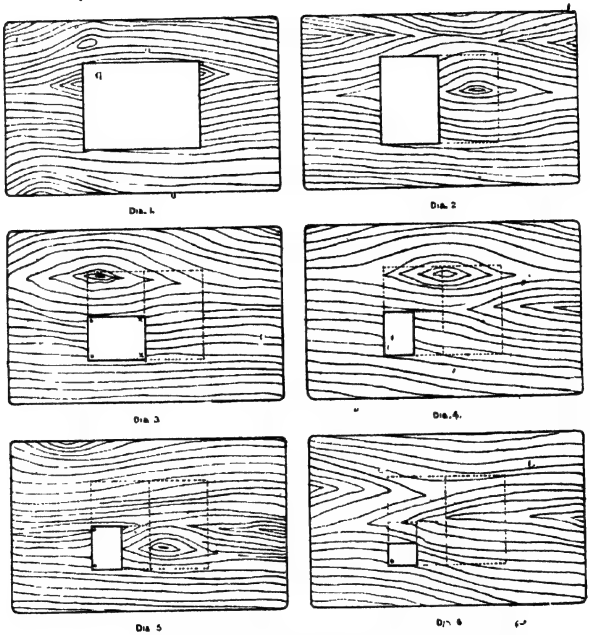


FIG. 25.—Folding a Sheet to find Imposition of Pages.

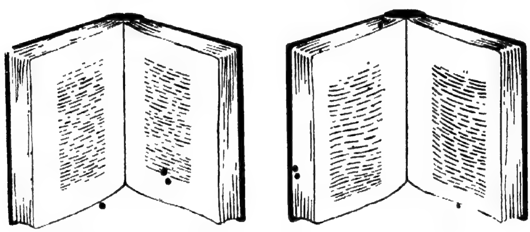
the case, especially when the work is to be lithographed; for this usually means that the book is not an ordinary one, and that many of its pages are of an irregular character, and are made up of diverse drawings and designs, interspersed here and there with type matter. Be this as it may, the margins must be decided upon by some one, and therefore all interested in the get-up of the work ought to know something about them.

The first thing to consider, in deciding this point, is the general character of the contents; whether, for instance, it is of

a business nature, such as a catalogue, or whether it is a work of art or similar work especially designed to adorn the book-shelf. In the first case, the nature of the matter might not lend itself to much artistic display on the part of the patcher—the whole feeling would be rather one of severity—but a great deal more scope might be allowed for individual taste in the latter case. Whatever be the nature of the work, a liberal margin always looks better than a scrimped one. Then it should be noticed that the margins at the back edges should always be less than those at the fore edges; otherwise the book has the appearance of having been cut down. The accompanying sketches (Fig. 26) will serve to illustrate what is meant.

As regards the top and bottom edges, it is always better to keep the work a little high; for when it is put exactly in the centre, it has the appearance of being lower than it really is.

The size of a crown octavo book, after being trimmed, is



Correct Margins Incorrect Margins

FIG. 26.—Diagrams showing Margins.

about $7\frac{1}{8}$ in., × $4\frac{3}{4}$ in. $\frac{3}{4}$ in. having been trimmed from the foot, $\frac{1}{8}$ in. from the top, and $\frac{1}{4}$ in. from the fore edge. The general width of margin allowed on a book of this size is about $\frac{3}{4}$ in. at the bottom and fore edges, and three-fourths of this—or whatever space may have been decided upon for the fore edge—may be allowed for the top and back edges, after the trimming has been allowed for.

There is yet another important point to be observed when type is being dealt with (especially by the lithographer, because he is not nearly so well up in bookwork as the letterpress compositor), that is, the correct position of a portion of a page which either begins a new chapter, or is the finish of the previous one. In the first instance a liberal top margin (often called a *sink*) is allowed—say one-fourth of the page—and in the latter case the work is kept up to its usual place at the top, even though there may be only a few lines of it altogether, the rest of the page being left blank.

Sticking down the Transfers.—An adhesive suitable for sticking down the transfers may be made from flour paste and a

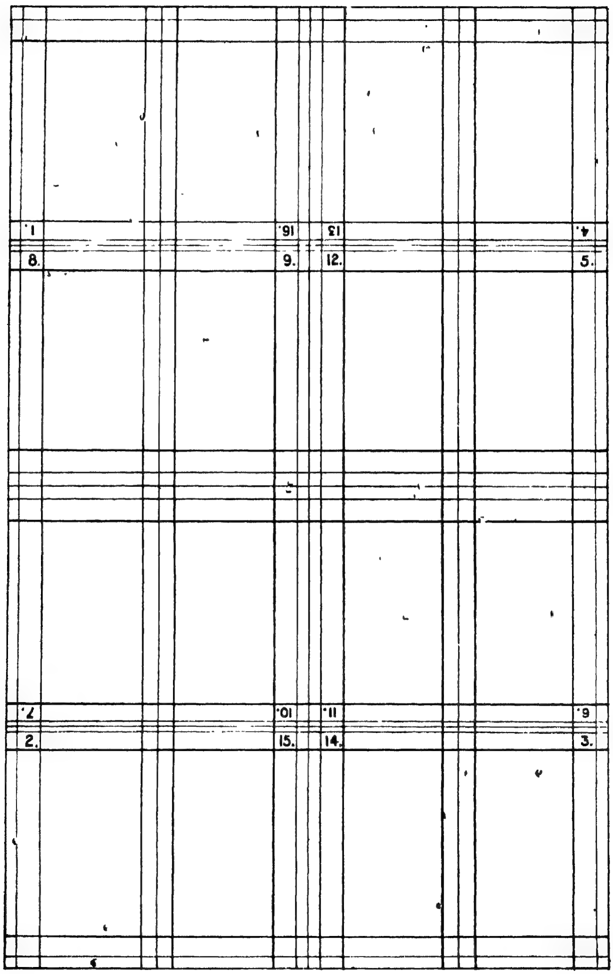


FIG. 27.—Plan of 16 pp. Booklet or Section, with the Margins and Allowance for Trimming.

little glycerine or syrup, but treacle (black molasses) should be avoided. A strong adhesive for stout transfer paper may be

made by mixing together two parts flour paste and one part syrup, and then driving out the bulk of the moisture by heating. Whatever is used for this purpose should be of a more or less hygroscopic nature, so that it will readily release its hold on the application of moisture during transferring. Care should be taken that only a sufficient quantity is used to enable the transfer to stick; and every effort should be made to apply it to places where it is not likely to soak through and injure the work on the face of the transfer. The hands should be washed clean before commencing to patch up transfers; and these should be handled so as not to receive a greasy impression from the fingers.

The Key Sheet.—If the work in hand is a sheet full of coloured labels, coloured book illustrations, tickets, or such-like, having more than one colour, a key sheet must first be made up. On coloured work containing an outline, the key is generally printed as one of the workings, but when the design does not contain an outline, the same temporary outline key as used by the artist for offsets must be employed here. The transfers are fixed in position on the sheet, but on no account must the register marks round the work be cut off. This is now transferred in position to suit the machine, and after being prepared, an impression is taken from it upon a special sheet, which is called the *key sheet.* The work is then charged with ink, dusted over with resin, and gummed, when it is laid aside until the machine is ready to take it up.

A good, flat, unstretchable key sheet is made by cutting a piece of No. 5 gauge zinc to the size of the job in hand, and gumming a clean sheet of the paper upon either side. When the paper has dried, a permanent key sheet to suit two different jobs will be the result. Ordinary gum arabic solution may be used for this purpose, which allows of the paper being easily removed by soaking if the zinc should be required at some future time for other work. Before taking the impression on this key sheet, pull one or two impressions on plain paper to make certain that the impression on the zinc-covered sheet will be a perfect one; when it should be dusted over with French chalk in order to dry the ink. A small portion is now cut from the centre of each of the register marks on the transfer, and the transfer is then stuck in position on the key sheet, so that the register marks on the transfer fall dead upon those on the key sheet. Of course, transparent transfer paper may be used for this purpose, and the register marks will not be required; but the same quality of impression cannot be obtained upon this paper as upon a semi-moist, opaque transfer paper. All the colours are stuck-up to the same key, after which it may be put away until the same job comes on again.

Treatment of Small Patches.—Where a considerable number of small patches from copper and steel plate engravings are required to make up a page or design, it is better to mark off the work on a sheet of transfer paper, and stick down the patches directly on to this, especially if the work is to be transferred to a damp stone. Owing to the necessarily limited amount of adhesive material in the transfer paper composition, it will be readily understood that a very narrow strip of the paper, such as a transfer containing a line of small lettering, would not stand the best chance of adhering to a damp stone during the first run through the press under pressure; but if the patches are stuck down on a sheet of good adhesive stone-to-stone transfer paper, there will be very little risk of anything going wrong in this direction. If a copy of the work already exists, it is a simple matter to place a piece of transparent transfer paper over it, sticking it down at the corners, and then, without any ruling off whatever, to stick the patches on in position. The whole may then be separated from the copy and placed in position on the lay-out sheet.

CHAPTER IX.

HAND AND POWER TRANSFERRING AND PRINTING PRESSES.

Mechanism of the Transferring Press.—The transferring press (Fig. 28) is a machine of very simple construction. It consists of an oblong iron framework standing about 3 ft. high. Above this, near to the centre, is a strong cross-head, from

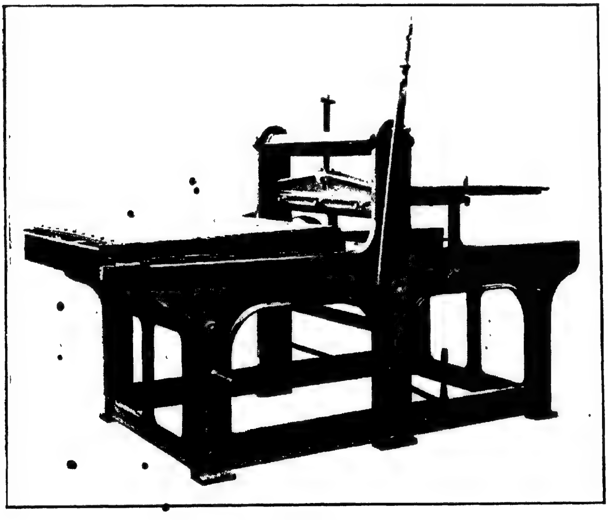


FIG. 28.—The Transferring Press.

which is suspended a screw for raising and lowering the scraper-box. Resting upon rails, which run along either side at the top of the framework, is the stone carriage; and immediately below this, directly under the scraper-box, there is a plain friction roller or cylinder, which may be driven by either hand or power. When the carriage containing the stone

(or iron bed-plate, if zinc or aluminium is in use) is pushed under the scraper-box, a long lever is pulled down so as to raise the friction roller by means of cams (Fig. 29), and so jam the carriage and stone firmly against the scraper, which, of course, must first be adjusted by means of the screw to suit the thickness of the particular stone in use at the moment. If the roller is then made to revolve by turning the handle (if it is a hand-press) or putting on the power, the carriage will be driven through under pressure, by which means transferring is carried out or impressions are taken. The stone, however, does not come into direct contact with the scraper, as a sheet of leather, card, or metal, called a *tympan*,[1] and two or three sheets of paper intervene.

The Broadway Press.—There is another style of press called the broadway press. It is similar to the ordinary press, but the stone or plate passes through the broad way instead of lengthwise. By this means the work is transferred in the same direction as the sheet is printed on the machine, which makes it easier to obtain good register. It should not be made in larger sizes than quad demy, as it requires much more power to drive than the same size running lengthwise would do.

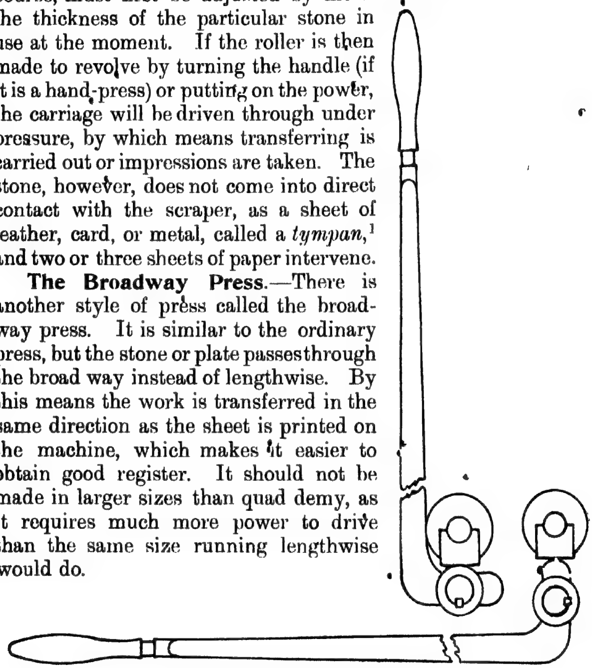


FIG. 29.—The Cam-Lever Action.

The Top-lever Press.—This type of press (Fig. 30) is of continental origin, and is more modern than those already referred to. Instead of the friction roller being raised, in this case it is the scraper that is lowered. It is claimed that the pressure is very elastic and yielding, thereby lessening the risk of breakage, and it requires less labour to pull it through.

Tympans.—The tympan in most general use on small and medium-sized presses is made of leather. This is perhaps best where a general class of work is done, but if metal is preferred, zinc

[1] The tympan is intended to protect the transfer from damage when passing through the press under pressure.

should be selected. On the large transferring press tinned steel should be used. For small hand-presses paper tympans (rolled card) are often used. Small tympans (metal or paper) need not be fixed in any way, but 2 in. at one end should be bent at right angles to drop over the back end of the stone, so preventing contact with the scraper when the carriage is pushed under. Large ones should be fixed into a gripper arrangement, and hinged at the back of the carriage. The front end may then be attached to ropes carried over pulleys fixed to the ceiling, with

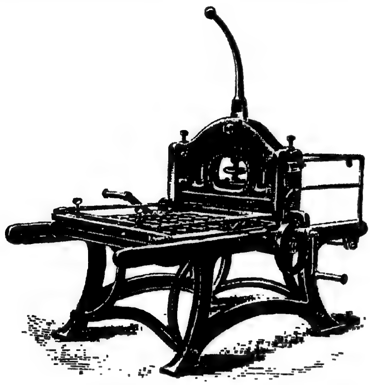


FIG. 30.—Top-lever Hand-press.

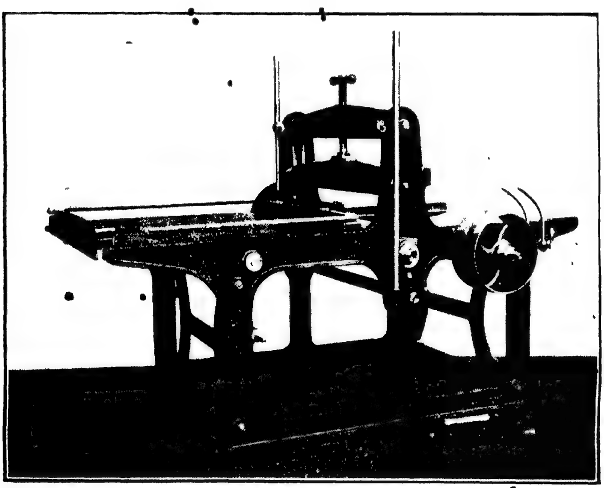


FIG. 31.—Furnival Double-lever Power Transferring Press.

weights dropping over the back of the press for the purpose

of pulling up the tympan as the carriage is being driven forward.

Scrapers.—The scraper is usually of boxwood planed V shape, and afterwards trued to the stone and nicely rounded. When in use with a metal tympan, it should have a strip of leather stretched tightly along the face and tacked with very small tacks at either end. There is no reason, however, why a scraper should be of wood at all; an iron one (Fig. 32) answers the purpose admirably, especially in the large sizes. A casting may be made from a wooden one, and slot holes afterwards sunk to allow the scraper-box screws to fit in as supports. The edge which comes into contact with the tympan must be carefully trued to a straight-edge, and then very nicely rounded with a fine file and emery cloth. Two layers of good chrome leather are then fixed over the face by means of small bolts at intervals which go right through the iron, and are fastened with a nut on the other side, thus holding the leather in position. A scraper treated this way can, unlike a wooden one, be relied upon for

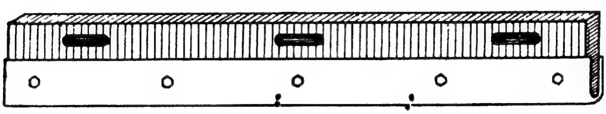


Fig. 32.—Iron Scraper.

months at a time, without any further attention, except the usual application of tallow or blacklead for lubricating purposes.

Need of Uniform Pressure.—While it is necessary to bestow considerable attention and care upon the face of the scraper, it is also important to give some heed to the back or top as well. Certain presses become known as *stone-breakers*. Work cannot be properly transferred in them without resorting to enormous pressure, although the bedding may have received every attention. The trouble is due to the top of the scraper box being untrue. For instance, if it were slightly convex, and the top of the scraper were also slightly convex, it is not difficult to imagine the tremendous pressure that would be required before the transfers along either side of the stone could receive the necessary amount of pressure to enable them to transfer properly, especially when we remember that the all-over pressure is applied from one central screw which comes into direct contact with the high parts of the scraper-box and scraper. After all, it is not very great pressure that is required so much as uniform pressure, as may be easily demonstrated by damping a clean stone, laying down the transfer, and rubbing it lightly

on the back with the handle of a pocket knife, a bone folder, or even the thumb nail. By damping and repeating the rubbing a few times, the impression will be transferred,

Adapting the Scraper to the Scraper-box.—The top of the scraper-box, of course, is a difficult place to get at, and therefore cannot be easily put right; so the scraper must be made to suit it. Take a little red ink on a brush and paint the inside top of the box right along; then insert the scraper and apply pressure by pulling down the lever on top of the stone in the usual way. Now take out the scraper and examine it. If the red ink has marked it only in parts, these parts must be planed, and the

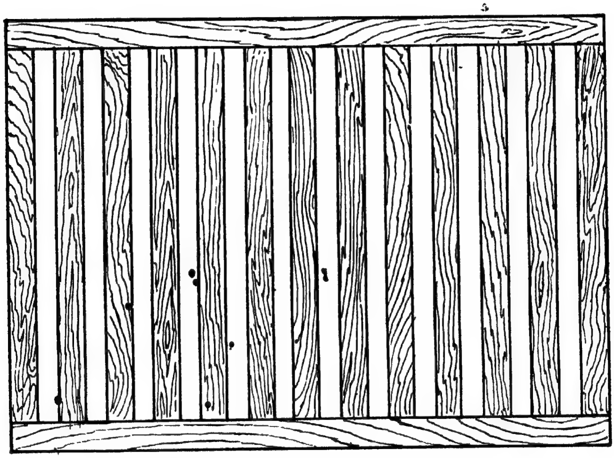


FIG. 33.—Board for Raising Thin Stones.

process repeated until it takes the red ink equally all along. If the scraper is an iron one it must be filed.

Bed of the Press and Packing.—The bed of the press, which is always of wood on the top side, must receive periodical attention. It should be tested with the straight-edge both lengthwise and across, and if necessary planed level. The iron straps underneath must also be examined from time to time, and worn ones removed before they give way. One ply of cork bedding, covered with a sheet of stout zinc, is then all that is necessary to complete the outfit, with the exception of a board (Fig. 33) which is required to bring up the thickness of thin stones. It is a great mistake to pack up thin stones with a lot

of soft bedding, and a solid wooden board is also bad, as it is impossible to prevent warping. A much better plan is to have a board of spars only. These should be about 3 in. broad by 1 in. thick, with 1½ in. between, which will considerably minimize any risk from breakage. The cork bedding and zinc must be placed on top of this.

Cleanliness Essential.—A transferring press should not be used as a cleaning-up bench, as is too often the case; for with such use it is quite impossible to prevent gum, acid, resin, etc., from getting about it, which will sooner or later cause trouble by spoiling work. It should be kept scrupulously clean and well oiled. The packing used for untrue stones should not be too thick, but should be nicely tapered and without sudden drops. If the paper used is of the thick wrapper variety, the edges should be first feathered by tearing.

CHAPTER X.

TRANSFERRING.

A Fascinating Art.—We have now arrived at what may be described as the most fascinating branch of the art, namely, the laying down of the transfers on a prepared stone or on a zinc or aluminium plate, and thereafter chemically treating the surface so as to enable the work to be printed upon paper, cloth, or tinplate by means of one of the various makes of lithographic printing machines.

Importance of Cleanliness.—As in everything else lithographic, cleanliness may be said to be of first importance, but there is perhaps a greater necessity for the observance of the rule at this stage of the work than at almost any other. A clean bench and press; clean cloths and sponges; clean water; a clean stone or plate; clean hands and clean transfers; all these are simple and effective aids to good work. Dirt, carelessness, and disorder cause trouble, needless labour, and vexation. There are other aids at the disposal of the transterrer, but they are more or less of a chemical nature, and may turn out to be hindrances of a serious kind, if not used with care and forethought.

General Considerations in Transferring.—Many considerations must be taken into account previous to laying down the transfers, such as the simplest and best method of treating the stone to suit the particular class of transfer on hand; the quantity of damp that will be required to ensure the particular transfer paper sticking with the first pull through the press under pressure; whether the stone should be treated with alum solution, and if so, what is likely to be the effect of such treatment upon the class of transfer about to be transferred; and whether it would be better to use a medium or a heavy pressure for the first pull through. All of these things, and more, will flash through the mind of a thoughtful man before taking any decided step, and he will soon learn from experience that to get the best results from the various classes of transfers he will require to alter or modify the treatment as occasion demands.

The Transferring Process in Outline.—The stages of

the transferring process are set out in order here before the details of each are explained. They are as follows:—

1. Treatment of stone with alum, bicarbonate of soda, nitric acid solution, or pumice powder.
2. Damping the stone or plate, or damping the transfers between damp sheets.
3. Laying down the dry transfers on the damp stone or plate, or the damp transfers on the dry stone or plate.
4. Passing the transfers through the press under pressure and damping them at intervals.
5. Soaking off the transfers.
6. Drying the stone or plate.
7. Gumming the stone or plate.
8. Washing out the transfer (aluminium only) with turps and developing it in asphaltum. Wash off with thin gum.
9. Charging the transfer with ink.
10. Dusting with acid resist (resin and French chalk).
11. Cleaning away the dirt (commonly called cleaning-up).
12. First etch with nitric-gum solution (weak).
13. Wash off and fan dry.
14. Gum-up (good coat) and fan dry.
15. Re-gum (very thinly) and fan dry.
16. Washing out transfer with turps on top of dry gum. Wipe dry.
17. Developing transfer in asphaltum. Wash off with thin gum.
18. Rolling up with black ink roller very sparingly charged with thin ink.
19. Dusting with acid resist (resin and French chalk).
20. Second etch with nitric-gum solution (stronger).
21. Washing off solution and fanning dry.
22. Final gumming. Again fan dry.

Treatment of Stones with Alum Solution.—A prepared lithographic stone, as we have already stated, is highly sensitive to the action of fatty acids, but it may be made even more so by treating the polished surface with a weak solution of alum,[1] with or without the addition of nitric acid. This treatment will not only make the surface more sensitive, but it will thoroughly cleanse it of any trace of deleterious matter that may have happened to get upon it, which, of course, is the ideal condi-

[1] Dissolve 3 oz. alum in 80 oz. water, and add ¼ oz. nitric acid. For use add two parts of this to sixteen parts of water. After setting the pressure, flood the stone with the solution, using the transferring cloth for the purpose, and then wash with plenty of pure water. Leave only sufficient damp to ensure the transfers sticking with the first pull through the press under pressure.

tion for all litho printing surfaces previous to laying down the transfers.

A stone treated with alum, however, is not a suitable surface for all classes of transfers; but for transfer impressions from stone or metal plates which contain very fine work, and which must of necessity carry only a very limited amount of fatty acid in the ink, and also for very fine lithographic writings, and for transfers which have been kept for a considerable time, nothing can be better, provided the transferrer is prepared to carry out the subsequent operations required by this treatment. To transfer a crayon drawing done on grained transfer paper, however, or a litho-drawing transfer containing heavy lettering and masses of soluble writing ink, to a stone treated in this manner would probably prove fatal, no matter what the subsequent treatment might be.

Effect of Alum Treatment.—When a lithographic stone is treated with alum solution, an adherent crystalline film, soluble in acids such as nitric and hydrochloric, but insoluble in water, is at once formed upon its surface. This film is highly sensitive to the action of fatty acids, and it may be readily understood that if a transfer containing ink that will not dissolve in water, such as re-transfers from stone, zinc, or aluminium, copperplate, stone-engraving, and type transfers, is transferred to this sensitive surface, the work must necessarily take a very firm hold, and that the ink cannot be dissolved during the damping and soaking-off of the transfer paper. But if, on the other hand, the transfer is one that has been drawn with lithographic crayon or lithographic writing ink, both of which are very soluble in water, owing to the large proportion of soap they contain, there would be a considerable risk of these dissolving out during the damping and soaking process, with the probable result that wherever the dissolved ink had made its way to, there it would remain permanently. This dissolving out of the ink would, of course, take place just the same had the stone not been sensitized with alum, but the dissolved matter would in that case not be likely to take hold owing to the desensitizing effect which the transfer paper composition has upon the raw stone.

Warm Stones.—A stone is sometimes warmed by placing it in front of a fire or in a chest or oven heated by steam, the object being to make it more sensitive to hard plate transfer inks and fine litho writings. If this is done, the transfer must be dampened between sheets of damp blotting-paper, so that it will adhere to the dry, warm surface. The method is now somewhat antiquated, and necessitates not only the heating of the stone but also the cooling of it, with the risk of cracking

during either process. It involves a considerable loss of time, which is a handicap to the trade generally, and the young lithographer should make every effort to attain the desired result by quicker and safer methods.

Other Methods of Preparing a Stone.—There are other methods of preparing a stone previous to laying down the transfer, but these are adopted more for the purpose of ensuring thorough cleanliness of the surface, or for slightly roughening it with a view to minimizing the risk of the ink spreading with such transfers as copperplate or stone engravings, or litho writings, drawings, etc., which appear to contain too much ink, than for the purpose of increasing its sensitiveness, as is the case with alum. For cleaning the stone, a solution of bicarbonate of soda may be used in the proportion of one teaspoonful to half a pint of water; or it may be sprinkled over with dry, crisp pumice powder and scoured with a felt pad or ball of clean paper, and dusted off with cotton wool. This method not only cleans the surface but also slightly roughens it. Another method, which gives a still rougher surface and holds the damp well, and is useful when transferring a large sheet of copperplate transfers, is to wash over the stone with dilute nitric acid. The acid should be of such a strength as to effervesce slightly when applied to a dry part. It should be applied by commencing at one end and going regularly over it until the other end is reached, but taking a fresh dip of the solution for each few strokes of the cloth or sponge.

Testing the Scraper.—When the stone has been set in position on the bed of the transferring press, and before treating it by any of the above methods, it should be covered over with a sheet of paper, and the scraper—if it is a wooden one—tested. This is done by placing several short strips of paper at intervals across the stone, and the scraper on top of these, and then trying the strips by pulling. The loose ones indicate hollows which must be removed by rubbing down the high parts on coarse sand-paper. Another way, which will save the trouble of taking out the scraper if it happens to be even, is to mark the sheet, after adjusting the pressure, with a black Conté crayon or piece of charcoal, from edge to edge of the stone. Then lay another sheet on top and run through the press under pressure. If the lines have offsetted uniformly, the scraper is all right.

Adjusting the Pressure.—Two or three clean sheets should now be placed next to the stone, and on the top of these a loose sheet of zinc (No. 7 or 8 gauge). The tympan is then brought down, the carriage pushed under the scraper, and the pressure adjusted. If it is necessary to use packing at one or other end

of the stone, it should be done with great judgment. To prevent a sudden drop in the pressure, each ply of paper, if it is thick, should have the edge torn (feathered), not cut, so that the whole will form a gradual taper beginning with three, four, or more plies, and terminating about the centre of the stone with one ply.

Transferring the Work to the Printing Stone.—The stone having been sensitized with alum, cleaned with bicarbonate of soda solution, rubbed over with pumice powder, or roughened with dilute nitric acid, according to the nature of the transfer in hand, it must then be washed with plenty of pure water, after which the damp is reduced by wiping with a cloth and wringing the cloth until only enough moisture is left to enable the transfer paper to stick to it with the first run through under pressure. The running through is then continued for a number of times, after which the back of the transfer paper is dampened. The damping and running through are repeated several times—care being taken not to prolong the process unnecessarily—until the work begins to show through the paper; or, in other words, until the paper begins to turn transparent by reason of the water going through it. Then apply hot water, or hot water and gum, if the transfers have been drawn in ink which is soluble in water (lithographic crayon or writing ink).

Preparing the Stone for Desensitizing.—Having soaked off the transfer paper and washed the stone clean, it must be fanned until all traces of damp—not merely surface water—have disappeared, which will occupy only a few minutes, owing to the slight heat created by the application of the hot water. When this has been done, the stone (or metal plate) must be put through a process of etching with suitable diluted acids as an aid to the action of the gum arabic solution, which is the chief desensitizing agent used in lithography; but the work must first be protected. It should be clearly understood here that it is not the work that requires to be etched, but all the other parts of the stone or plate which do not contain work. This cannot be done without carrying the acids over the entire surface; hence the necessity for putting the work in a condition to withstand them by treatment with an *acid resist.*

Acid Resists.—The best acid resist is, without a doubt, fine flour resin; but as there is not enough ink upon the transfer to hold the necessary amount of resin, this must be augmented by a fresh supply. This is a very important stage of the process, and is usually the making or the marring of the job. The work may be charged with an additional supply of ink by first gumming over the stone or plate with fresh, clean, gum arabic solution; then fanning it dry, washing it off again, and rolling

it over with a black ink roller until the work is fully charged. It may also be done by rubbing it up with a pad of soft cotton cloth (such as used for covering foreign beef and mutton) sparingly charged with thin black ink in conjunction with gum arabic solution ; or by a combination of the two processes—first rubbing-up and then rolling. The work will then be in a condition to absorb a sufficient quantity of the fine powdered resin, which will form a protective film to it while the rest of the surface is being etched and prepared to receive the gum arabic solution. This gum solution will combine with the stone and form a new compound capable of attracting moisture and opposing a moderately greasy printing ink, while the actual work will attract the printing ink and oppose the moisture.

The Inking-in Process.—The action of gum arabic solution upon the newly transferred work and surface is a very mild one, and it is difficult to see how the early stages of preparation could be carried on were it otherwise. This weakness, however, in the later stages (the final gumming) has been one of the drawbacks to the trade ever since it was established over one hundred years ago ; but a remedy has been found which will be described in the following chapter. Upon a stone that has been treated with alum, gum arabic has very little action at all until the crystalline film has been removed at a later stage by dilute nitric acid (the first etch). Now it will not be difficult to understand that if the inking-in process is attempted by rolling over the stone with a black-ink roller while it is in such a glazed, sensitive condition, the edges of the work, which are the first places to repel the damping water and become dry, will take grease from the roller, and in a few minutes hold it so firm that it really becomes part of the work itself and cannot afterwards be got rid of. This is the reason why the use of alum is so often condemned by those who have failed to employ it successfully and have not made a study of the subject.

Now suppose that the work which is to be transferred is a large sheet of transfers from various sources, say transfers from grained stones, fine air-brush work, engraved headings, etc., which would contain all the gradations possible to get by the lithographic process, and that it is transferred to a stone that has not been chemically treated with alum, and the work then charged with ink by rolling after the usual gumming. It would soon become apparent, owing to the weak nature of the transfer ink, that to retain the very finest work on the stone, it would be necessary to use thin ink on the roller ; and this in turn would cause the heavy three-quarter tints to become clogged. On the other hand, if the ink is worked stiff and spare for the

sake of keeping the work on these heavy parts open, then it will be at the expense of the fine work, which will disappear altogether.

A Better Method of Inking-in.—The combined method of inking-in the work will give much better results, and is carried out, as already explained, by first rubbing-up the work and afterwards rolling it up. The treatment is as follows. After adjusting the pressure, the stone is washed with clean water only, and the quantity of water is then reduced until only enough is left to enable the paper to stick with the first run through under pressure, or the transfers may be dampened between damp sheets until sufficiently adhesive, and then laid down on the dry stone, after which the transferring is carried out in the usual manner. The stone is afterwards gummed over with fresh, clean gum, and the work charged with ink by rubbing-up with a pad of soft cotton cloth and thin black ink, into which some transfer ink has been mixed. Rub-up the work with the right hand, and follow this up occasionally with the gum sponge contained in the left hand. When the work has been fully charged, all superfluous gum should be wiped off, and the stone should be laid aside until, if possible, the following day. By the laying aside of the stone for several hours, the work benefits in a two-fold manner. In the first place, the transfer has received a fresh supply of greasy ink, of which it makes use during the interval by attacking the stone and obtaining a firmer hold. The gum solution does the same thing on the parts not taken possession of by the transfer, so that the work is in a much better condition to withstand the rolling which it afterwards receives, because the finest tints will have taken a firm hold of the stone, and the three-quarter tints are not so liable to become clogged.

The First Etch.—The gum must then be washed off, and the work rolled-up with a black-ink roller containing a moderate supply of ink of medium consistency, after which it is dusted with fine flour resin, cleaned-up, and then etched with nitric-gum solution of sufficient strength to effervesce slightly when applied to a dry corner of the stone. An etching solution should do its own work. Do not attempt to assist it by rubbing parts of the work with the sponge. After it has been allowed to act for a few minutes wash it off, dry the stone, and give it a coat of gum, which must then be fanned dry. The object of etching a stone with nitric-gum solution, as already explained, is to assist the action of the gum coating which it afterwards receives. This it does by breaking or roughening the surface and making it more absorbent. The first etch, which is a mild one, cannot do this properly, but its action is sufficient to allow the transferrer to re-

charge the work with a firmer resist and prepare it for the second and stronger etch.

The Second Etch.—This second or stronger etch should have the effect of roughening or chemically graining the surface and putting it into the best possible condition to receive the final coating of gum. It should be about half as strong again as the first etch, but it should not effervesce with a rush when applied to the stone. Before this can be applied it will be necessary to protect the work further, and here again different methods obtain. It is the custom with some transferrers to roll-up the work again on top of the existing ink and resin with a little thin ink on the roller. The work is then dusted a second time with the acid resist and the stronger etch applied. This method is certainly a quick one, and the two layers of ink and resin form a very strong, acid-resisting film, which allows of a free application of the etching solution.

Defects of the Above Method.—After the second etch the stone should be washed clean, and then fanned dry and gummed over with fresh, clean gum arabic solution. Then after drying, it is the general practice to lay it aside until the machine is ready to take it up, which may occur within an hour, or it may be several days. It must stand to reason, then, that by adding another film of ink and resin to the original one, every line and dot must have been appreciably thickened (broadened as well as heightened), and that the stone's surface has been encroached upon at these parts, so that it cannot be acted upon by the etching solution. These, too, are the parts which are most in need of the treatment. Then, again, if the stone has been laid aside for a few days in this condition, even though the machineman may get a satisfactory proof passed, a mysterious thickening of the work soon begins to manifest itself, causing the machineman to use undesirable methods to keep the work sharp. The eventual result may be that the printing turns out badly, or that the transfer has to be put on again.

The Great Principle of Transferring.—The great principle, then, which the transferrer must ever keep in view if good printing is to be done, is: Never Lose Sight of the True Condition of the Work. Have no excuses for work appearing thick such as "it is in resin just now, but it will be all right when it is washed out" and so on. Such excuses are at best only "blinds," and the good workman will avoid making use of them. Unless the stone is etched each time right up to the actual work, and the gum allowed to take effect, it will be quite impossible for it to print properly on the machine; and to make matters worse, the consequences are usually laid upon the wrong man, namely the printer.

There is also a great drawback to the combined method in the time required to carry it out, which is a serious matter if either the customer or the printing machine is waiting for the work. Both of the foregoing methods of charging the work with ink, then, must be condemned; the first because it is incapable of producing the best results, and the second because it is not in the best interests of the trade to adopt any method which cannot be carried to a satisfactory termination without considerable delay.

Rubbing and Rolling-up.—Every lithographer, and especially every transferrer, is aware how easy a matter it is to charge delicate work with ink by rubbing-up as compared with rolling-up, and it is no uncommon thing to hear a workman remark that his job "will rub-up all right, but whenever he puts a roller upon it, it goes away". This proves that rubbing-up is a much more kindly way of treating the work than rolling-up; and keeping in view that our only object during the early stage is to increase slightly the quantity of ink on the transfer, so that the acid resist (fine powdered resin) may have a little more matter to adhere to, it is questionable whether a roller should be used at all.

Summary.—We may now sum up our subject so far as follows:—

1. Transfers containing ink which is insoluble in water, such as transfers from stone or metal plates, copperplate, engraved stone, type, and very fine litho writings, may be transferred with advantage to a stone (cold) treated with alum; but alum must be avoided when the ink used is one which is soluble in water, such as a drawing made with lithographic crayon on grained transfer paper, or a drawing done on plain transfer paper in lithographic writing ink (except very fine writings). In these latter cases a plain polished stone must be used, or one slightly roughened with dilute nitric acid (no gum), or rubbed with a felt pad and pumice powder. When nitric acid or pumice powder is used, wash well with pure water afterwards.

2. The work should not be charged with ink by rolling-up with a black ink roller, but should be rubbed-up with a soft cotton dabber and thin ink, and a gum sponge.

3. It is quite unnecessary to disturb the ink after rubbing-up by using a roller.

4. A second film of ink and resin on top of the original film, as an extra acid resist, is not conducive to good printing.

A Detailed Practical Description.—Having described the means of making a stone more sensitive, or otherwise preparing the surface to suit the various kinds of transfers; and having also described some of the different methods employed in preparing the work for printing, and explained the reasons why

certain parts of the process should not be adopted, the remaining portion of the chapter will be devoted to showing in detail the means of obtaining the best results on a commercial basis.

The First Inking.—Having completed the transferring, soaked off the transfers, washed and fanned the stone thoroughly dry, gum it over with fresh, clean gum. Now rub down a little black ink with extra thin litho varnish until it is quite soft and workable; but take care that it is not merely varnish with a little ink in it. While it is necessary that it should be soft and workable, it should have a good body of colour. Dip the dauber or pad well into this, and then work it about on a clean part of the slab, until all free ink has disappeared. Then proceed to rub up the work with it. Bear in mind that only a very thin, uniform film of ink is required on the work; but at the same time it must have enough. If the work is rubbed-up unnecessarily full, there will be danger of its becoming permanently thickened. Now wipe off the inky gum with the damping cloth, using, if necessary, a little pure water from the sponge. If the stone is a large one,it is better to have two cloths, reserving a clean one to finish up with. Then fan it dry.

Applying the Acid Resist.—The work should now be carefully examined and compared with the copy. If any parts appear to have been missed in rubbing-up, the stone should be re-gummed and the parts rubbed-up again, and the gum then wiped off as before. The transfer should now be an exact facsimile of the original (if from stone or metal plate), just as it appeared when charged with transfer ink previous to taking the impression. If everything appears to be satisfactory, dust the work over with the finest flour resin, and then lightly, on top of that, with French chalk. As the solid parts of the work are always more liable to be damaged by the acid than the fine work, it is better to assist the amalgamation of the resin and the ink at this stage by rubbing the parts with the finger. The stone may now be washed over with the water sponge, and the dirt cleaned away with picker and polishing stone, when it is ready to receive the first etch.

Picker and Polishing Stone.—A good picker may be made from a small three-cornered file (see No. 7 in Fig. 11, on p. 34), ground to a point of medium length. If the point is made too long, it is apt to cut too deeply into the stone, and it cannot be held in proper position; if it is too short, the shoulders of the point are apt to cut away work. The picker should be held in the same manner as a pen, with the hand resting upon a sponge or cloth. It should be kept sharp, and only the very surface of the stone should be lightly *scraped,* so as to avoid making cuts or holes. The polishing stone is a slip or pencil of Water of

Ayr stone, and is used by first wetting the stone with the water sponge and then polishing away the dirt while in this condition.

The First Etch.—The etching solution should consist of thin gum, with just sufficient nitric acid in it to create a very mild effervescence when applied to a corner of the stone. A broad brush, a sponge, or a soft, open cotton cloth may be used to apply the solution, but care must be taken not to rub the work, or it may be injured by the solution undermining it. Apply it freely, and allow it to do its own work; then wash it off; fan dry, and gum over with a coat of good, fresh, clean gum, rubbing it with the flat of the hand while fanning dry.

Preparation for the Second Etch.—The work is not yet in a fit condition to withstand the wear and tear of the printing of a long edition, owing to the surface of the stone not having been made sufficiently absorbent to benefit to the full extent by the mild desensitizing action of the gum arabic solution; so it must be etched again, but this time with a stronger solution. Before this can be done, the stone must be re-gummed with thin gum, and then wiped down with a soft, dry cloth—not a damp or wet one—until only a very thin, even film is left, which must be fanned thoroughly dry. Now wash out the work with turps (using a dry cloth and no water) on top of this film of dry gum; and, having wiped away the inky turps, pour on some asphaltum solution,[1] and distribute this quickly and evenly over the surface with another dry cloth. These cloths and bottles should all be kept together in a fire-proof box made for the purpose.

Up to this point nothing of a watery nature has been used during the washing-out process, but it must be used now to remove the asphaltum from all parts of the stone except the work. This is done by washing the stone over with thin gum, and afterwards with pure water, when the work will be distinctly seen developed in the protective, acid-resisting asphaltum film, and it will readily take ink from the black-ink roller with which it is now rolled-up.

The condition of the inking roller at this stage is an important matter. The stone having already been given a liberal etch with nitric-gum solution, followed with a coating of gum arabic, there can be no fear whatever of any immediate tinting of the stone or clogging of the three-quarter tints; and it will be quite unnecessary to risk weakening the fine work by using stiff ink on the roller, besides giving oneself extra labour. Charge the

[1] Dissolve 1¼ lb. asphaltum powder in ½ gal. benzolene by standing the vessel in hot water (not near a fire); then add ¾ gal. turpentine and 2 oz. olive oil or melted tallow, or a little oleic acid. If for use on zinc, omit all grease, but gold size or terebene may be used.

roller well with some of the same thin black ink that was used for rubbing-up the transfer, and then scrape it clean and wash the slab, when it will be in the right condition for rolling-up the work.

Give the work plenty of firm rolling and it will be all the better for it. If everything appears satisfactory, dust over the work with resin and French chalk just as before, not forgetting to rub over the solids lightly with the finger, and then wash away the superfluous resin, etc., with the water sponge. If the work is now examined, it will be found that the addition of the resin and chalk has made practically no difference to its appearance. Every line and dot will be found to be clear and sharp, and the three-quarter tints just as open as on the proof copy ; and the whole, being protected by the asphaltum, the ink, and finally the resin and chalk, is in a condition to withstand a good etch.

The Second Etch.—The second etching solution should be somewhat stronger than the first, but it is a mistake to make it too strong. Try it as before on a corner of the stone ; if it effervesces a little more than the first one, it will be right. While the stone is still damp, apply the solution sparingly at first, and then liberally, taking great care not to scrub the work. Now wash it off, using a soft sponge and pure water, and then fan dry. The surface has now been roughened, or grained, and made absorbent by the action of the etch; and it is in a much better condition to benefit by the desensitizing action of the arabic acid contained in the gum solution with which the stone is now coated. The gum must be thoroughly dried before the stone is sent to press.

Etching for High Relief.—It is sometimes considered necessary, when hand-made or other hard, rough papers are to be printed upon, to have the work on stone well in relief of the base, so that it may the better impress itself into the rough grain of the sheet. This is obtained by simply repeating the process of washing-out, inking, dusting with acid resist, and etching as described for the second etch until the desired relief has been obtained.

Transferring Autographs to Stone.—What is generally termed an *autograph transfer* is a writing done upon plain writing-paper with lithographic writing ink, and with a person's own hand. It may take the form of a circular letter, an architect's or builder's schedule, or any kind of office work containing much detail, such as measurements, prices, etc. Sometimes a great many different forms have to be printed, only a few copies being required from each.

With this class of work it is not so much quality of printing

that is required as a true facsimile of the detail contained in the original writing. This might, of course, be done upon lithographic writing transfer paper, but the person who does the writing is not used to transfer papers, and may cause considerable trouble from greasy finger imprints appearing through the work when transferred. Then again, there is always a risk of something going wrong during transferring which would necessitate the whole being rewritten, and this might lead to friction with the customer. On the other hand, if the writing has to be done on plain paper, and from want of proper damping or pressure the transferring has not been successful, it may be re-damped and tried a second or third time if necessary.

The process is a very simple one if the few rules which govern it are observed. A fair pressure is required, and the press scraper must be strictly true with the stone, as the transferring is done with one pull through only, the paper having no adhesive quality like transfer paper. First examine the writing, and re-touch any part which appears to be broken, or contains an insufficient quantity of ink to transfer properly; then lay it face down upon a sheet of clean paper, and damp it on the back with a sponge containing a little dilute nitric acid and alum, just as would be used to sensitize a stone. Then adjust the scraper and pressure, re-damping the back of the transfer at intervals as it shows signs of drying. Have some pure turpentine at hand, and a ball of cotton wool or tissue paper.

It cannot be too strongly emphasized that the success of the operation depends more upon the correct damping of the transfer than upon anything else. Examine the back and see whether the paper has assumed a more or less transparent appearance, with the work quite readable as seen through it. If this is not so, then it must be made so. Dampen the back of the transfer again, and rub it all over with the fingers until the writing is plainly readable in all parts. If the transfer is now turned over and the face examined, it will be found that the rubbing has caused water to appear in places, which should be absorbed with a piece of blotting-paper or tissue. It will also be noticed that the ink which was previously dry is now moist and ready to offset upon anything with which it may come into contact. It is then ready for transferring.

Pour just a little turps on the stone and distribute it with the cotton wool or tissue paper, and then wait for it to become absorbed or to evaporate. When this has taken place, lay down the transfer in position and place one or two sheets of clean paper on top and then pull through the press under pressure—once only. If the transfer was laid down too soon, while there was still free turps upon the stone, the turps would cause the

ink to flow, and both the original and the offset would be permanently thickened.

If the transfer is a circular letter, it is sometimes necessary to print a copperplate heading along with it. The position of the heading should be marked off on a sheet of the paper, which, in turn, is laid in position upon the clean stone and marked off. The clean stone is then dampened, and the copperplate transfer laid to the marks, and pulled through under pressure a few times. The autograph transfer is then transferred as already described, *taking care not to allow the turps to get on to the heading transfer. It should then be rubbed up very sparingly with black ink, and the gum fanned dry. The transferring of the heading is then* proceeded with. The whole of the work is then treated as an ordinary transfer; but it will not be necessary to etch twice, unless a long edition is required.

Transferring to Metal Plates.—The first thing to consider when about to lay down a transfer on a zinc or aluminium plate is whether it is a freshly prepared one or otherwise. If there is any doubt whatever about this, the plate should be rubbed over with a felt pad and some dry, crisp, fine pumice powder. This must be done very lightly in a manner describing small circles to imitate the mechanical grain the machine gives as nearly as possible, but care must be taken not to overdo it. The plate is then dusted with clean cotton wool until all traces of powder have been removed, when the transferring may be proceeded with in exactly the same manner as with stone, pure water only being used for damping. It should be completed with as little delay as possible, especially with aluminium, as the plates are so sensitive to damp that they easily corrode, so requiring the work to be all re-done.

Zinc Transfers.—If the plate is a zinc one, coat it with a liberal supply of fresh, clean gum, and then work the gum off again by wiping it with a sponge and squeezing it out until only a very thin film is left on the surface. Then charge the work with ink by rubbing-up exactly as directed for stone. If there is too much gum left on the plate, there will be difficulty in getting the work to catch the ink. A few drops of water will be required from time to time to thin the gum. Do not load the dauber with ink, but work it as bare as possible; and do not be concerned if the plate appears to take on a tint while the rubbing-up is proceeding. A rub with the gum sponge will remove that at once. It is afterwards treated exactly like a transfer upon stone, but, of course, a different etching solution is used. A suitable etch for zinc and aluminium plates may be made up as follows: 80 oz. water, 3 oz. sodium phosphate, ½ oz. ammonium nitrate, ¼ oz. phosphoric acid. Bichromate of

potash and chromic acid are also used for this purpose, but these are very poisonous and should be avoided.

Aluminium Transfers.—If the transfer is on aluminium, gum it over as directed for zinc, but this time wipe the gum down with a dry cloth until only a faint trace of it is left. Then fan thoroughly dry. Wash out the transfer with turps, using a dry cloth ; then apply asphaltum solution as directed for stone, and when dry, wash off with gum solution. The work is now charged with ink by rubbing-up exactly as described for stone and zinc, using the same etch as recommended for the latter.

Cleaning-up Metal Plates.—In cleaning-up the work on metal plates, great care must be taken to preserve the original grain on the surface. Polishing, as on stone, is not permissible ; but if certain parts cannot be cleaned without removing the grain, it must be replaced by as close an imitation as possible. A good plan is to sharpen a small piece of wood about the thickness of a lead pencil, pointed at one end and flat at the other. Dip this into caustic soda solution, and then into fine pumice powder. Now remove the dirt by rubbing the part in a manner describing tiny circles, taking great care not to allow the caustic solution to touch the actual work. If it is absolutely essential to use a picker on certain parts, see that it is a sharp one, and touch the parts only very lightly with it.

CHAPTER XI.

A SIMPLE, LABOUR-SAVING TRANSFERRING PROCESS.

Established Practice.—For many years the theory has been accepted—and wherever good printing is done, it has been carried into practice—that to obtain the best results from a transfer upon a lithographic stone, it must be at least twice etched with nitric-gum solution; that the work must be brought into slight relief by the etching; that the polished surface must be roughened by the action of the nitric acid before it can benefit to the fullest extent by the mild action of the gum arabic solution; that this roughening is also necessary to carry and hold the damp, and to grip the inking rollers and prevent skidding; and that the work must be washed-out with turps and developed in asphaltum, just as recommended in the previous chapter.

Great Care and Skill Required.—To carry out this work properly, however, considerable time is required, and it calls for care and for skill of no mean order. This is particularly true of the part of the process following the first etch, as it is from this point onwards that the transferrer meets with most of his troubles. If he should decide not to carry his work beyond the first etch, but to gum up finally at this stage, he merely postpones the troubles for the printer, which not only places an extra burden upon the shoulders of the wrong man, but is very bad economy.

The Troubles Obviated by a New Process.—Every transferrer is aware how simply and effectively the work may be carried through up to the point of charging it with ink, dusting it over with resin, and giving it a weak etch; and how great is the temptation to "shelve" it at this stage The new process of preparing to be described in the following paragraphs enables this to be done, and at the same time produces better work. Another important feature of the process is that exactly the same simple treatment is applicable to all litho printing surfaces, stone, zinc, and aluminium.

The Arobene Treatment Described.—The new method is as follows. Transfer the work to a thoroughly clean stone or

metal plate, using no alum on the stone, and charge it with ink, preferably by the rubbing-up method described in the previous chapter. Then dust it over with the finest flour resin and, on top of that, with French chalk, not forgetting to assist the amalgamation of the resin and ink on the solids by rubbing the parts lightly with the finger. After the work has been cleaned in the usual way, and the stone or plate fanned dry, gum it over with the fixing preparation known as Arobene.[1] Then, after drying, the work is ready for printing. The Arobene should be applied with a soft sponge kept for the purpose, which should be washed immediately after using it; otherwise it will become hard. The solution should not be put on thickly, but treated just like ordinary gum, using the flat of the hand to smooth it before fanning it dry. The Arobene should not be removed until the machineman is ready to print.

The Two Methods Compared.—In order to show the weakness of the old etching method as compared with the new, the following interesting experiment may be tried. Mark off a lithographic stone into two portions. Etch one portion with the usual nitric solution, and then gum it up. Coat the other with Arobene, and allow all to dry. When this has been done, wash off each portion separately, using a clean sponge, and then wash the whole under running water, and fan it dry. Now make some lines with a brush and lithographic writing ink right across both sections of the stone; then fan the ink thoroughly dry. The ink should now be washed off clean with turps, and the stone rolled up with a black-ink roller, when it will be found that the lines on the portion etched with the nitric-gum solution come up firm and solid, whilst the other portion of the stone remains blank. This shows that the film which the Arobene has deposited is absolutely insensitive to the most powerful grease. Of course, alterations and additions may be easily made upon a stone or metal plate previously treated with Arobene, but the parts must be resensitized by applying dilute nitric acid to stone, and weak acetic acid with alum to zinc or aluminium, and afterwards washing well with pure water.

Advantages of Arobene.—The cost of Arobene is insignificant when compared with the great saving in time and material, and the general improvement in the quality of the work.. One ounce (or less) of Arobene is sufficient to cover a stone or plate 45 in. × 35 in., and the time saved by the transferrer will be one to three hours or more, according to the nature of the work and the difficulties likely to be met with. As regards the machineman, it will stand to reason that if the work is sent to press in a sound, healthy condition, on a stone or plate with

[1] Arobene is manufactured by Morris & Bolton, Ltd., London.

which there is no danger of tinting and little likelihood of any doctoring of the work being required, a very quick start must be the result. With certain enamel papers which give considerable trouble by causing the stone to tint, and by biting through the work, the difficulty may be entirely overcome by adopting the Arobene method, especially if the pressure is set just up to printing point, and no higher. The pressman may then use a little more of his favourite ink-doctor in the printing ink, which will do away with the biting tendency of the paper.

Treatment at End of Day.—It is also recommended that, at the end of the day's run, the stone should be inked in with the machine rollers, the work dusted over with French chalk, and the stone then gummed up with equal parts of gum and Arobene. The quantity of Arobene, however, must be decided to a large extent by the nature of the ink with which the work is charged. Next morning the usual start may be made without washing-out the work.

Preparation for Machine.—When the machineman receives the stone or plate, the Arobene should be removed by washing off with water. A little gum solution is then distributed over the surface, and wiped down until only a thin even film remains, which must be fanned thoroughly dry. The transfer is then washed out with turps or naphtha—which should contain a little oleic acid (4 oz. to 1 gal.), olive oil, or other grease, if it is for stone or aluminium, but if for zinc it is better to omit everything greasy—and then, after wiping-up clean with a dry cloth, apply asphaltum solution as recommended in the previous chapter. It is better to remove the asphaltum, after fanning it dry, with watery gum solution.

Arobene for Proofs.—Arobene will also be found most useful when a number of transfers or proofs are required to be taken from the original stone, as the treatment will make it impossible for the stone to tint.

CHAPTER XII.

REDUCING AND ENLARGING BY MACHINE PROCESS.

Usefulness of Reducing and Enlarging Machines.—One of the most useful adjuncts to an up-to-date lithographic establishment is the reducing and enlarging machine, or pantograph, and the quality of work that may be done by it cannot be excelled by any other process. Even in large offices where a photographic plant is in operation, reductions are generally executed on the reducing machine when the work already exists upon stone or copperplate. The reason for this is that it is a direct transfer method, from one stone to another, but instead of a sheet of transfer paper a sheet of indiarubber is used as the carrying medium. The process is cheaper than photography, and there is also the special advantage of the work being done in the department. The process is especially useful for reducing and enlarging show cards, labels, engraved views, letter headings, transfers from type, woodcuts, etc., and all classes of lithographed chromo work.

The Fougeadoire Machine.—The type of machine most generally used at the present day is that by M. Fougeadoire, of Paris (Fig. 34). It is made in several sizes, and intending purchasers would be well advised to decide upon a size larger than may be considered absolutely necessary.

The base of the machine consists of a strong, square, iron framework, resting upon four fixed legs, which stand about 12 in. high. Around the inner side of the framework are four rods with a screw arrangement at either end. On each screw there is a block or carrier, containing a stud projecting from the top, and this in turn fits into a hole at the end of each of the four bars which form the expanding frame; so that when the rods are caused to revolve by the turning of the handle the carriers are compelled to travel in one or other direction, taking the bars with them. At the near left-hand corner there is an arrangement of gearing, for the purpose of working all four rods simultaneously, or one opposite pair only, at the will of the operator, so that the frame may be extended or reduced in either direction or both. The rubber sheet is held in position by small screw

clamps attached to brass lattice work, which covers the movable bars, and which expands or contracts as the frame is enlarged or reduced, the clamps and rubber sheet, of course, travelling along with it. There is also an expanding angle piece at each corner, for the purpose of holding the movable bars square and rigid during the taking or transferring of the impression. On the inner side of these four angle pieces, just inside of the movable bars, there are four long screws, one at each corner, which act as legs for the expanding frame when it is detached from the machine and turned face down over the stone to receive or transfer the impression. The legs may be lengthened or shortened to suit the thickness of the stone.

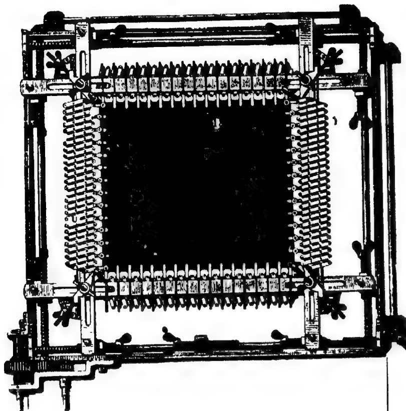


FIG. 34.—Fougeadoire Reducing and Enlarging Machine.

Coating for Rubber Sheet.—The rubber sheet, as it comes from the maker, is covered with a white preservative coating, which must be cleaned off by rubbing with a sponge and hot water. If it is already in position on the machine, it must be coated with a special elastic composition which may be made as follows. Soak $1\frac{1}{2}$ oz. gelatine in 18 oz. cold water, and afterwards add $2\frac{1}{2}$ oz. golden syrup. Dissolve the whole by heating, and then add eighteen drops of carbolic acid as a preservative. As this composition has the property of attracting moisture, it must be understood that more or less of the syrup will be required according to local conditions. A small quantity of this should be warmed, and distributed with a piece of sponge over the rubber sheet. Then finish off by passing the hand over it while fanning it dry, until the coating has the appearance of being uniform and without streaks. The coating must be done while the rubber is down to its normal size (not stretched), whether for enlargement or reduction; but if for the former, the coating should be put on very spare.

Application to New Work.—Newly transferred work does not, as a rule, give a satisfactory impression on the rubber sheet if the stone has been etched with nitric acid. This is due to the tendency of the rubber to adhere too firmly to the raw surface of the stone; therefore, after etching, it should be allowed to remain under gum for a few hours at least, or better still, all night. If, however, the stone is treated with Arobene instead of nitric acid and gum, it may be used immediately after the preparation has been dried upon it.

The work should then be washed out in the usual way, and a few impressions pulled from it in transfer ink. When a firm, sharp print has been obtained on enamel paper, the same amount of inking should give a good result on the rubber; but the work should be rolled up rather fuller if it is to be enlarged. The transfer ink should be made up of equal parts of transfer ink and hand-press black, reduced to easy-working consistency with extra thin litho varnish.

When the work in hand is to be reduced, the rubber must, of course, be extended first, and the frame secured by means of the screws at the corners; but if it is to be enlarged, it should only be extended enough to clear the band and clamps from the edge of the stone from which the impression is to be taken.

Proper Condition of Coating.—The quality of the impression depends a good deal upon the condition of the composition. If this is in proper order, it should be dry enough to take the ink from the stone, and at the same time it should have just sufficient "stick" to grip it, so that it does not move while the impression is being rubbed down.

Taking the Impression.—The impression is sometimes taken by setting the stone in the transferring press and arranging the rubber and frame over it so that it may be pulled through under pressure as an ordinary print would be taken; but there is considerable risk of destroying the rubber by this method.

Place the stone containing the work upon a bench of convenient height and adjust the frame over it by shortening or lengthening the legs until the face of the rubber just barely touches it. Then put two or three sheets of stout paper of the size of the stone on top of the rubber, and, without hesitation, place a glazed hand-roller firmly on the centre of the paper, and roll it backwards and forwards for a few times with sufficient pressure to cause the rubber to stick. It is better now to lower the frame somewhat, so that there will be no tendency of the rubber to spring up. (See Figs. 35 and 36.)

Burnishing.—The burnishing proper is then done. This is best carried out with a small roller burnisher, having a handle of about 20 in. in length, which is allowed to rest against

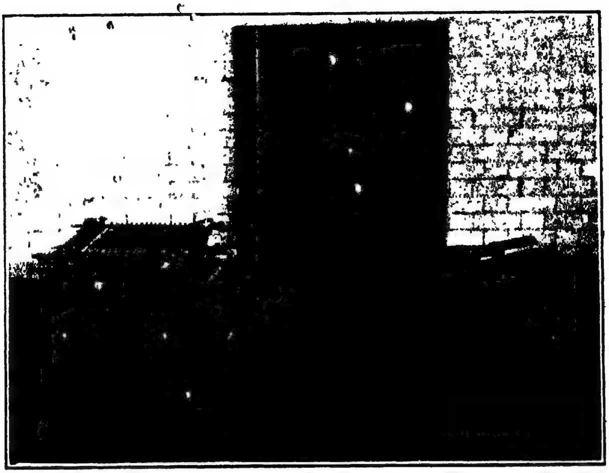


FIG. 35.—Frame in Position to Receive or Transfer the Impression.

FIG. 36.—Frame replaced on Machine ready for Reducing or Expanding.

the shoulder while pressure from the body is brought to bear on the roller. Owing to the sensitive nature of the rubber and composition, it will not be found difficult to rub down a good impression. Excellent results may also be got by greasing the back of a piece of enamel paper with tallow, and rubbing with a strong folder or the back of the handle of a pocket knife.

The Reducing or Enlarging Process.—The frame is then raised at one end, if possible by lengthening the screw legs, and the rubber carefully and slowly released from the stone; after which it is placed back into the machine. Then loosen the screws and extend or reduce the frame until the impression has attained the desired size. Tighten the screws again, lift the frame out, and adjust it over the clean dry stone to which the enlarged or reduced impression is to be transferred. When everything is ready, the frame should be lifted up at one end to admit of the stone being dampened. It is then again placed in position as soon as all surface water has disappeared, the transferring being done in exactly the same manner as the impression was taken; but a little water may afterwards be injected under the rubber to assist in releasing the composition and transfer. The stone should be sensitized with alum, and the work afterwards treated by rubbing-up with black-ink dauber and gum as recommended in Chapter X, but not rolled-up.

Application to Chromo Work.—For chromo work the key or black outline must be done first, and an impression taken on a sheet of gelatine which has been previously varnished on both sides to prevent its being affected by atmospheric conditions; the colours are then reduced or enlarged to fit this. To get exact register it will be necessary at a certain stage to lock-up the frame, lift it out and stand it on end, and "shine-up" from the back of the rubber. Once the register has been obtained, great care will be required in transferring the image to stone, as the rubber is so liable to distortion. Nearly everything depends upon having the frame nicely adjusted, so that the rubber almost touches the stone; and also upon the manner in which the hand-roller is passed over it. A few sheets of bright enamel paper on top of the rubber previous to passing the roller over will help to prevent distortion.

CHAPTER XIII.

TRANSPOSING AND REVERSING.

Meaning of Transposition.—Transposing is a term used to denote the reversing of a design, that is, converting what may be called a positive design into a negative one or vice versa. Take, for example, a plain type transfer. Under ordinary circumstances this would be transferred and printed with black or coloured ink letters on a plain paper background, giving a positive print. Transposition of this transfer would produce a black or coloured ink background, with the plain paper showing through the letters—a negative print.

The process always excites interest in the mind of the young lithographer, because to him there is an element of magic about it; but apart from that, it is well he should know how to proceed, as he may be called upon to do it at any time as part of his everyday work. (See Figs. 37-38.)

The Relief or Polishing Method.—There are at least three different methods of achieving the same result, all of which are good if carried through in an intelligent manner. The first and oldest of these is the "relief" or "polishing" method. This consists in etching the stone several times (protecting the work each time by washing-out, rolling-up, etc.), with dilute nitric acid until the work is sufficiently in relief to allow of a slip of fine polishing stone (Water of Ayr or Snake stone) being rubbed over the top of it without interfering with the base. When the desired relief has been obtained, namely the thickness of a business card, the work should be washed out with turpentine and a clean cloth. The whole of that portion of the stone must now be made sensitive (*affinitized*) by washing with dilute citric acid, or with dilute nitric acid and alum, followed with plenty of pure water, and then thoroughly dried. A pencil line should now be drawn round the work to where the solid is to be extended to, and the space afterwards filled in with strong lithographic writing ink, which must be fanned dry. Now gum round the remaining parts of the stone and fan dry, and afterwards wash away the solid mass of ink with turps and a dry cloth, and develop the whole in asphaltum as recommended in

Fig. 37.—Work to be Transposed. (See Fig. 38.)

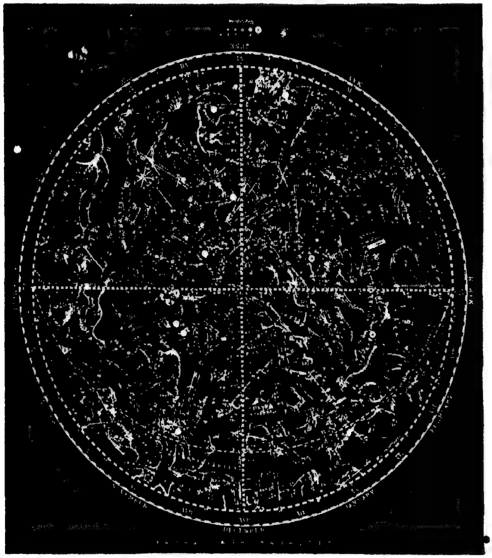


Fig. 38.—Fig. 37 Transposed.

Chapter X. It will then be a comparatively simple proceeding to polish lightly over the top of the work with the slip of polishing stone and water, as it stands up in relief from the base. When this has been done, the work, which is now reversed, may be charged with ink by rolling it with a sparingly charged hand-roller covered with black ink, using a very weak etching solution if necessary to prevent the polished parts from again taking ink. The work is then dusted with resin and talc, and etched. The washing-out, rolling-up, and etching must be repeated until the parts that were in relief are etched down slightly below the new surface. This method is still practised in many places, but it is a slow process and cannot be recommended as up-to-date.

The Gum Method.—The second method is termed the "gum" process. A good print is taken with stiff black ink upon an ordinary hard-sized paper; and while the ink is still wet and on the surface of the paper—that is, immediately after the impression is taken—it is dusted over with very finely powdered gum arabic (gum acacia), and afterwards with clean cotton wool. The latter dusting must be thoroughly done, as every speck of gum left on the surface of the paper represents a white speck when the work has been transposed. Sometimes a very small proportion of tannic or oxalic acid powder is mixed with the gum, but this is not necessary.

The press scraper should be dead level with the stone, and set with a good pressure. The stone is then dampened with pure water only, the gummed impression laid in position and pulled through under pressure once only. The result is an impression of the image in gum, which must be fanned dry. Now mark off with a pencil where the solid is to extend to, and gum over all parts of the stone outside of this; then fan thoroughly dry. Next, with a transfer-ink roller, ink the stone over solid. The ink may now be removed with a little turps and a dry cloth and replaced by asphaltum. Fan the asphaltum dry, and then wash over the whole with a spongeful of thin, clean, gum solution, when the reversed work should show up sharp and clear, developed in asphaltum. It is then charged with ink, either by rolling, or by rubbing-up with a dauber; dusted with resin and talc; cleaned; and then coated with Arobene or etched with nitric-gum in the usual way. The method is very simple, and good, quick results may be got by it. Success depends chiefly upon the damping of the stone previous to laying down the gummed impression. Too much damp would make the gum spread, and cause sharp lines to become irregular; and too little damp would mean that the gum could not adhere properly.

The Transfer Method.—The third method is perhaps the

best of all, and may be termed the "transfer" process. The transfer is put down upon a clean stone (no alum or other sensitizer being used) in the usual way, and afterwards charged with ink—preferably by rubbing-up—dusted with resin and talc, and then cleaned; using the picker very lightly. The stone is then placed upon the water trough, flooded with dilute nitric acid and alum to clean it thoroughly and sensitize it, and afterwards washed with pure water and dried. Now fill in the prepared part with strong lithographic writing ink, dissolved in water, and fan dry.

Principle of the Transfer Method.—The principle of this method is as follows. Certain parts of this solid mass (all parts except where the original transfer is) have taken a much firmer hold of the stone than the remaining parts (the parts covered by the original transfer). Now if the whole of this ink can be cleaned off with some searching liquid strong enough to erase the weak parts chemically, but not of sufficient strength seriously to affect the more powerful writing ink, it will stand to reason that when the stone is afterwards rolled over with a black-ink roller, everything must come up except on those parts where the original transfer was.

Having fanned the lithographic writing ink dry, pour upon it a quantity of gum arabic solution and plenty of turpentine, and then, with a clean cloth, as quickly as possible dissolve the ink, mixing all together. Do not attempt to work up a tint on the design with the inky gum, but get rid of it quickly. The stone is then rolled-up with a black-ink roller, previously well scraped, until the work appears strong and firm; dusted with resin and talc, and subjected to the usual etch.

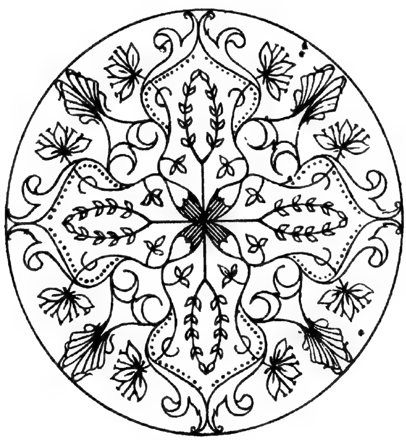
This method is recommended as being the best for fine, sharp work; and good results are easily and quickly obtained after one or two experiments.

Reversing Transfers.—Reversing is quite different from transposing. In the latter case the image, as already explained, is converted from a positive design to a negative one; in reversing, however, the image remains positive, but simply reads or appears in the opposite direction to that of the original, the right and left sides being interchanged. For instance, a fancy design might be required for a complete border; or to show a centre-piece of a floral or ornamental ironwork design, lace work, etc. It would only be necessary for the artist to draw a small section of the work, and the whole could afterwards be made up from a number of ordinary transfers and an equal number of reversed transfers. If the original section of the design is transferred, and a transfer impression taken in the usual way; and if this transfer is laid upon the stone face uppermost, and another

piece of clean transfer paper laid face down upon it, and the whole pulled through under a good pressure, it will be found

Original Transfer.

Reversed Transfer.



Completed Design.

FIG. 39.—Illustrations of Reversing.

upon separating the transfer papers that the original transfer has offsetted a considerable portion of its ink on to the other piece

of transfer paper, forming an exact reverse of the original. Both of these transfers may be used—the reversed one of necessity—but it is better to take extra transfers for the originals. (See Fig. 39.) The best transfer paper to use for this purpose is the semi-moist.

The "Reverso" Transfer Reversing and Offset Proving Press.—This press, manufactured by Waite & Saville Ltd., is suitable for a wide range of work. It reverses transfers, takes offset proofs, proves offset and tin-printing work in colours, takes direct proofs from stone or plate, and takes letterpress proofs. Its chief use, however, is for reversing transfers. As much original work exists in a reversed condition on stone, aluminium, or zinc, it is necessary to reverse such work to suit the offset process, and the commonest practice has been to take one transfer and then pull a second transfer from it to lay down on the plate, thus causing a considerable loss of sharpness and delicate detail, besides wasting time. With the "Reverso," one transfer only is required, and clearer, brighter, and sharper designs are transferred to the plate than have hitherto been possible, while the saving in labour is very considerable. The cylinder is furnished with a gripper for carrying the sheet. (See Fig. 40.)

The method of working is as follows. A print is taken from the copperplate upon plate transfer paper, using copperplate transfer ink, and this transfer is transferred to the printing surface and prepared ready to print the necessary reversed transfers. The stone or plate is then set in the "Reverso" press, and an impression taken on the rubber-coated cylinder. This impression will read from left to right. A tympan is laid on the stone and the cylinder raised the thickness of the tympan by half a turn of a small hand-lever. The transfer paper is then fed into the grippers and turned through the machine, thus imparting the design on the cylinder to the transfer paper, reading from right to left as on the original stone or plate.

A number of transfers are taken by this method and prepared for the machine plate for offset work. Original work existing on stone will be treated in the same manner when transferring for the offset process.

The "Reverso" for Proving Offset Work.—Drawings and engravings, drawn reading from left to right, as required for the offset machine, cannot be proved direct in the old way, because on the proofs the work would read from right to left. In the "Reverso" press, proofs may be taken from the original drawings upon the rubber cylinder, which then gives its impression to the paper. Thus, when a customer wants a proof of his offset job, there will be no need to stop an offset press, and put

on the customer's plate to obtain an offset printed proof, as a perfectly printed proof can be rapidly produced on the "Reverso," and in any number of colours, so that the machine will also be found valuable in the tin-printing trade.

10 In proving colour work, the old method of laying the sheet to needle points is entirely done away with. Instead, the sheets are laid on the feed-plate to front and side gauges having delicate micrometer adjustment, while in the bed of the press a screw adjustment is provided for holding and regulating the stone or plate.

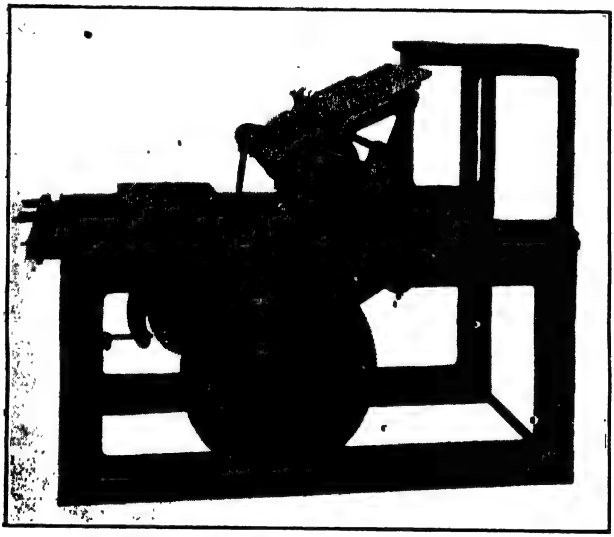


FIG. 40.—"Reverso" Press.

Other Uses of the "Reverso".—An impression may be taken on the rubber-coated cylinder from any type forme, and given on to the transfer paper, which is then ready for laying down on the plate or stone. When a direct proof is required, either letterpress or lithographic, a sheet is fed into the grippers and the impression taken direct on to the paper. The machine will take any thickness from a type forme up to 4-in. stones, and the change from one thickness to another is instantaneously accomplished. Stones and bed-plate are adjusted and locked in the bed by screws similar to those used in flat-bed litho machines.

CHAPTER XIV.

PAPER.

Paper-making Materials.—Paper is manufactured from various vegetable fibres by a kind of felting process. Wool is used in some grades of mottled papers, and a few thin threads of silk are sometimes found in certain cheque papers, but practically speaking animal fibres are not included among the materials of the paper-maker. The principal vegetable materials employed are the following: Cotton and linen rags, esparto grass, wood pulp, straw, hemp, and jute. Rags, esparto, and wood are by far the most important for writing and printing papers, the others being used mostly for wrapping and similar papers. The bamboo, bagasse (that is, the crushed stalk of the sugar-cane), the baobab, the paper mulberry of Japan and China, and a few other materials have been occasionally used in paper-making, but are of no practical importance.

Rags.—The finest qualities of writing and printing paper are made from linen and cotton rags, especially the former. White rags are preferable to coloured ones. Cotton contains more than 90 per cent of the fibrous material called *cellulose*, which is the basis of all paper, and in linen the percentage of cellulose is also high, more than 80 per cent. Cellulose has the chemical formula $C_6H_{10}O_5$, the same as starch, but it is an entirely different substance. The fibres of linen and cotton are long, being usually over an inch in length before treatment. The use of cotton and linen in paper-making dates back to a very early period.

Esparto.—Esparto grass, which grows in Spain and North Africa, was introduced for paper-making about the middle of the nineteenth century, and is now in very extensive use. Its percentage of cellulose is low, less than 50 per cent, and its fibres are very short, about one-seventeenth of an inch. An esparto or straw paper will become of a light yellowish-brown colour if exposed for some twenty hours to a temperature of about 230° F. (110° C.) in an oven, but a good rag paper will show no appreciable change under this test. The presence of esparto in a paper may be better indicated by heating it gently with a solution of aniline sulphate in water (1 part in 1000). A rose-pink

tint denotes esparto, the depth indicating the proportion roughly. Straw, however, reacts similarly with aniline sulphate, but by means of the microscope and after a little practical experience straw and esparto can be readily distinguished.

Wood Pulp.—The use of wood fibre prepared by a mechanical process for paper-making dates from about 1846, and twenty years later chemically prepared wood pulp was introduced. Britain now imports very large quantities of both chemical and mechanical wood pulp from Canada and the Scandinavian forest regions. Wood pulp is obtained from various trees of the coniferous or cone-bearing kind, especially spruces, silver firs, and certain pines; also to some extent from poplar and other broad-leaved trees. The percentage of cellulose exceeds that in esparto, but the fibre is present in a more woody condition. *Mechanical pulp* is simply ground wood, and by itself produces a very inferior quality of paper, liable to rapid decay through the oxidation of the non-cellulose materials. *Chemical pulp* is prepared by digesting the wood with a suitable chemical, chiefly bisulphite of lime, commonly called sulphite, and is a much better paper-making material.

A mechanical pulp paper will turn to a deep yellowish-brown colour when heated in an oven as described in the preceding paragraph. A solution of zinc chloride and iodine colours a mechanical pulp paper deep yellow, and gives a bluish tint to a chemical pulp paper. Aniline sulphate solution (4 parts in 100 of water) stains a mechanical pulp paper yellow, the depth depending on the amount of pulp present. Another test involves the use of a solution of 4 parts of phloroglucine in 100 of absolute alcohol and 50 of pure hydrochloric acid. This solution stains a mechanical pulp paper more or less red according to the amount of pulp present, but the presence of certain aniline colours will also give a red stain with this solution, even in the absence of mechanical pulp. The stain in the latter case is due to the hydrochloric acid, and develops suddenly and uniformly; and of course the acid alone without phloroglucine will produce it.

Other Materials.—*Straw* obtained from the ordinary cereal crops has been in use as a paper-making material for over a century, but it is very little used to-day, except in the manufacture of the packing material known as *strawboard.* A little straw pulp is added to some printing papers for hardening purposes. Straw is very similar to esparto in the nature of its fibres and in other ways, but it is of inferior paper-making quality.

Hemp is a comprehensive term covering a variety of strong fibres, containing from 64 to 80 per cent of cellulose. These include *common hemp,* cultivated chiefly in Russia and Italy,

with fibres over an inch long; *Manila hemp*, from the Philippine Islands, with much shorter fibres; and the *sunn hemp* of India, also with short fibres. Hemp fibres cannot be bleached to any degree of whiteness, but the finest qualities, as found in canvas and sailcloth, are used along with rags in making strong papers suitable for deeds, bank-notes, and ledgers.

Jute is a short-fibred material very similar to some forms of hemp, with which it is often mixed in canvas, ropes, etc. It is cultivated in India to a large extent. The percentage of cellulose in jute is about 64. Jute is unsuitable for use in making printing and writing papers, because it cannot be bleached to a pure white colour, but it is well adapted for the manufacture of brown and wrapping papers.

The Process of Paper-making.—The main stages in paper-making may be enumerated as follows:—

1. Preparation of the raw material.
2. Chemical and mechanical treatment of the fibres so as to produce *pulp* or *half-stuff*.
3. Beating of the pulp.
4. Manufacture of paper from the beaten pulp.
5. Finishing of the paper.

There are differences in the details of these processes according to the raw material in use, but the general nature of the process is the same for all materials.

Preparation of the Raw Material.—Rags intended for paper-making, after undergoing a process of dusting in a revolving cylinder, are freed from buttons, hooks and eyes, etc., then cut into small pieces either by hand or machine, and afterwards sorted out according to quality, colour, etc. The final preparation for the boiler takes place in a machine called a *willow*, which consists of a drum, spiked on the outside, revolving quickly inside a box provided internally with spikes. These spikes give the rags a thorough teasing, and all dust and dirt are thereby removed from them. Esparto grass and straw are prepared for boiling in practically the same way as rags, care being taken to remove all weeds, roots, etc.

The preparation of wood for mechanical or chemical wood pulp is naturally very different from the above process. The large logs are sawn into short pieces about two feet long, and these are then barked, either by mutual friction in a revolving drum or by means of a specially adapted cutting machine called a *barker*. If the wood is to be used for chemical pulp, the barked pieces are cut up into very small chips in a machine known as a *chipper* or *splinter machine*.

Making of the Pulp or Half-stuff.—Except in the case of

mechanical wood pulp, the pulp is made by digesting the prepared raw material with a suitable chemical substance in a *boiler or digester*. The chemical solution employed is usually caustic soda for rags, esparto, and straw, but for chemical wood pulp it is either bisulphite of lime, sulphate of soda, or caustic soda, the latter chemicals producing three different grades of pulp, called respectively *sulphite, sulphate*, and *soda pulp*. The bisulphite of lime, shortly called sulphite, is prepared expressly for the purpose in a suitable plant, in which sulphur dioxide gas, resulting from the burning of sulphur, is absorbed by lime or limestone.

With rags and usually with straw, the boiler used is a revolving one of spherical or cylindrical shape, but in the case of esparto a stationary cylindrical boiler is employed. The boiled pulp is subjected to a thorough washing in the *breaker* or *breaking engine*. This consists of an oval trough divided into two by a central partition called a *midfeather* running the long way of the trough, but not reaching to the ends. In one half of the trough the boiled rags or other material are further disintegrated by means of an iron roll with steel knives on its surface, which revolves just above a bed-plate provided with similar knives. In the other half of the trough there is a revolving *drum washer* adapted for carrying off the dirty water resulting from treatment of the rags, etc. A large quantity of pure water must be continuously supplied to the breaker while it is in operation.

The digester used in making chemical wood pulp is a tall steel cylinder lined with acid-proof brick or more usually lead-lined. In this vessel the wood chips are subjected to the action of the bisulphite solution and high-pressure steam for several hours, and the pulp so obtained is then thoroughly washed and afterwards passed through screens of various degrees of fineness in order to remove certain impurities and to sort it out into various qualities. It is then partially dried by pressing, or thoroughly dried by steam-heated cylinders. There is also a slow process of digestion for chemical pulp, which is better for certain kinds of paper, such as the strong, thin papers known as "banks" and also imitation parchment papers.

Mechanical pulp is made by pressing the wood chips against a large grindstone which revolves rapidly either in a horizontal or in a vertical position. As the wood is ground it is led off by a stream of water. As with chemical pulp, a process of screening follows to remove impurities and to sort out the pulp into various grades. The pulp is then freed from much of its water by pressure.

Bleaching the Pulp.—The pulp is very often bleached in the breaker, but this process may be carried out in separate

tanks called *potchers*, which are identical in construction with the breaking-engine. In the case of esparto and wood pulp, it is now often done in a special kind of large tower, with a centrifugal pump which causes the highly concentrated pulp to circulate from the bottom of the tower to the top. This saves a large proportion of the bleach, owing to the stuff being bleached cold and in a very concentrated state. The bleaching substance used is bleaching powder, otherwise known as chloride of lime.

Beating the Pulp.—The beating of the pulp or half-stuff is probably the most important operation in the manufacture of paper, because upon it depends, more than upon anything else, the quality of the paper to be made. The Hollander *beating-engine* or *beater* (Fig. 41), which is the one mostly used, is very similar to the breaking-engine or breaker, but there are more knives on the roll and the bed-plate, and they are somewhat differently arranged. The relative position of the roll and the

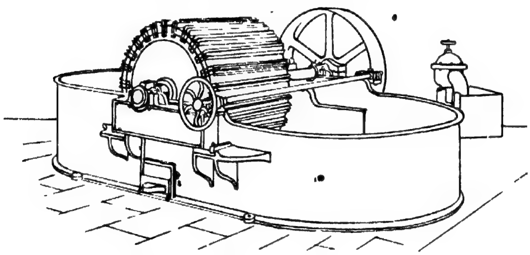


FIG. 41.—Hollander Beating-engine.

bed-plate can also be adjusted with greater precision, and upon the proper adjustment depends the quality of the finished paper.

Short fibres like those of esparto, straw, and mechanical wood pulp need but little beating, because the prolongation of the process has very little effect in changing the condition of these materials. The prolongation of the beating process has, however, the effect of hydrating the pulp, that is, combining it with water, thus producing a harder and firmer paper, but with greater liability to stretch. Rag pulp and chemical wood pulp, on the other hand, will give very different qualities of paper according to the time and conditions of beating. A blotting-paper, for instance, is made from pulp beaten only for an hour or two; a good printing paper requires from three to five hours' beating; whilst the strong, thin, transparent papers called banks and loans are beaten for nine or ten hours. Special types of beaters have been introduced for treating wood pulp, but it is unnecessary to describe them in this book.

Loading, Sizing, and Colouring.—Various chemicals are added to the pulp in the beating-engine before the paper is actually made. Some of these are intended to *load* or weight the paper by more or less filling up its pores and increasing its opacity, but the opacity of papers is not entirely due to loading. Others, called *sizes*, are added to remove the absorbent quality which, in blotting-papers, causes ink to soak into the paper and run through its substance. All writing and printing papers must be sized. Still other chemicals are added to *colour* the papers. Even white papers require to have a little colouring matter, usually blue, added to the pulp, because all half-stuff, however pure, has a yellowish tinge. The sizing is done on the finished paper in the case of high-class rag papers, especially hand-made papers.

The chief substances used for loading paper are *China clay*, which is a hydrated silicate of aluminium, *pearl hardening*, consisting of sulphate of lime and chalk, and *sulphate of barium*, the last being known as *blanc fixe* or *permanent white*. *Starch* is also used as a loading substance, and it has incidentally the effect of increasing the "handle" or toughness of the finished paper.

The chief sizing substances are *resin size*, *starch*, *gelatine*, and *glue*, the last two being essentially the same substance and being described generally as *animal size*. A paper which is sized in the beating-engine is called an *engine-sized* (or E.S.) paper; one sized by dipping in a bath or tub of gelatine solution is called *animal-sized* or *tub-sized* (T.S.). Resin size (or, more usually among paper-makers, rosin size) consists of resin combined with caustic soda or carbonate of soda to form a *resin soap*, which consists of resinate of soda containing free resin. A solution of sulphate of aluminium is added to the pulp after treatment with resin size, so as to precipitate resinate of aluminium and free resin. Another substance used in sizing papers is *casein*, which is prepared from milk. Papers with only a small amount of size are called *soft-sized;* well-sized papers, on the other hand, are said to be *hard-sized.*

The colouring matters added to pulp in the beater comprise various familiar pigments, such as Prussian blue, ultramarine, chrome yellow, Indian red, manganese brown, etc., but these are now almost entirely superseded by the more brilliant though more fugitive aniline dyes prepared from coal tar.

Hand-made Papers.—The finest qualities of rag papers are made by hand, but the great mass of commercial paper is machine-made. In the hand process the apparatus consists of a rectangular mould of wire-cloth enclosed by a wooden frame, and having a movable frame called a *deckle* to fit closely over it

(Fig. 42). A *vatman* dips this mould with its deckle covering into the vat of beaten pulp mixed with water, and lifts enough to produce a sheet of the proper thickness. He lets the water drain through the meshes of the wire-cloth, and shakes the mould about so as to produce felting of the fibres into a sheet of paper. He then passes the mould without the deckle to another workman, called a *coucher*, who places the wet sheet of paper on top of a felt sheet and then covers it with another felt sheet. After a pile of paper and felt sheets has been formed in this way, the whole is subjected to great pressure in order to dry the paper as much as possible. A *layerman* then takes out the partially dried paper sheets, and again presses them without intermediate layers of felt. The drying is completed by hanging the paper in airy rooms, usually with heated air.

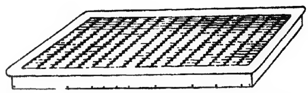


FIG. 42.—Mould for Hand-made Paper.

The wire-cloth mould may be of uniform small mesh, without any of the wires being distinctly larger than others, in which case a *wove* paper will be produced. Or it may have at intervals of about an inch, a series of parallel larger wires running across its breadth, in which case a *laid* paper will result. In either a wove or a laid mould there may be a distinctive wire design soldered on to the mould. This will show on the finished paper as a *water-mark*.

After hand-made paper has been sized, it is subjected to *plate-glazing*. This consists in forming a little pile of alternate sheets of paper and either zinc or copper, and passing it between the rollers of a plate-glazing *calender*, something like a mangle, under pressure.

Machine-made Paper.—The paper-making machine is an elaborate contrivance of great length, in which the beaten half-stuff undergoes a continuous series of operations resulting in its transformation into a finished paper. The first part of the machine, called the *wet end* (Fig. 43), is concerned with the treatment of the wet pulp, and the remaining part, called the *dry end* (Fig. 44), is concerned with the drying and finishing of the felted paper sheet. A detailed description of the machine is unnecessary here, but its principal parts and their uses may be summarized in order as follows:—

1. *Stuff-chests.*—These are the tanks containing the beaten pulp mixed with water. The pulp is kept stirred by mechanical agitators.

2. *Feed-box* or *Service-box.*—The pulp passes from the stuff-chests into a feed-box, or service-box, which is always kept full

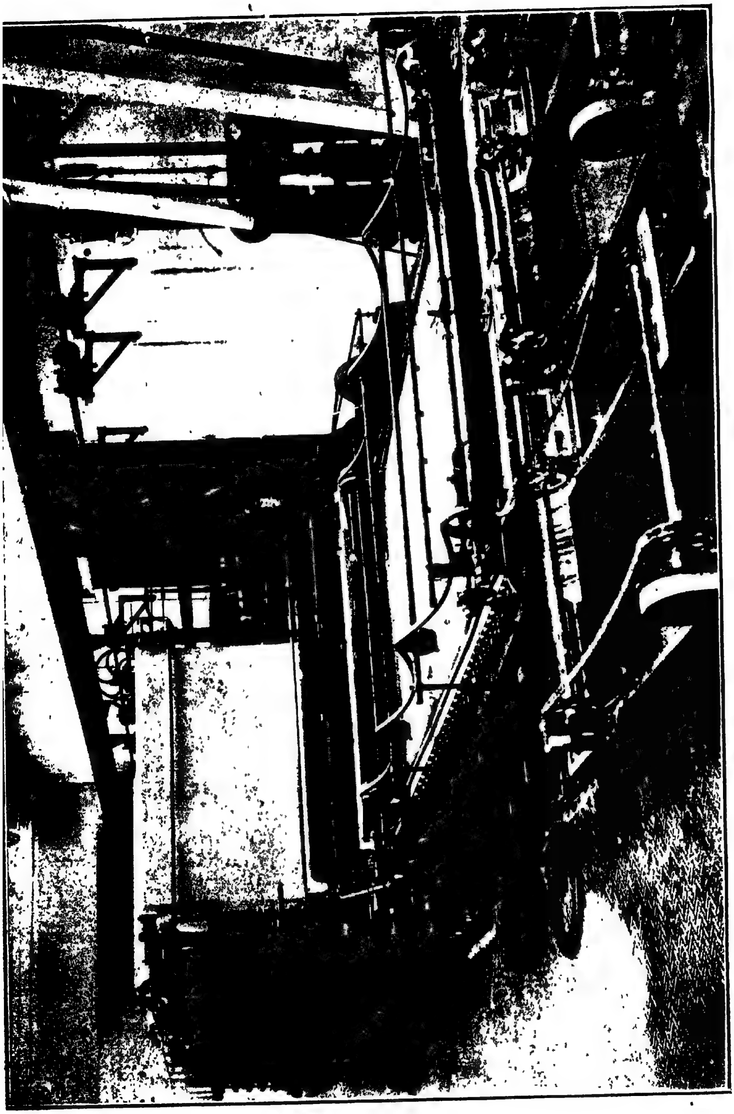


Fig. 43.—Wet End of Paper Machine.

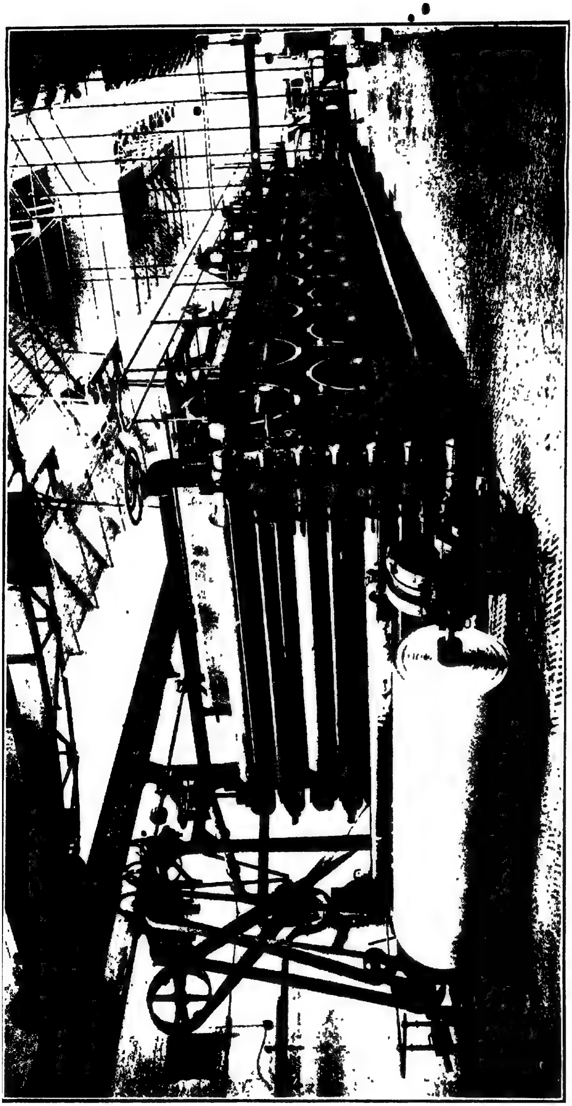


FIG. 44.—Dry End of Paper Machine.

to overflowing so as to give a uniform head to the machine. The rate of flow is controlled by a valve.

3. *Sand-traps.*—These retain impurities that are present in the pulp.

4. *Strainers.*—These serve to purify the pulp still further, by retaining lighter impurities that have not been taken up by the sand-traps.

5. *The Machine Wire.*—This is the essential part of the machine, corresponding to the wire mould in hand paper-making. The wire-cloth is 40 or 50 ft. long, and passes round rollers in an endless sheet. A thin strip of rubber, called an *apron*, guides the pulp on to the wire, and a brass bar, called a *slice*, placed over the wire, regulates the thickness of the pulp. The pulp is retained at the sides by endless rubber bands, called *deckle-straps*, which travel round brass pulleys. The water that drains through the meshes contains a certain amount of pulp and a considerable

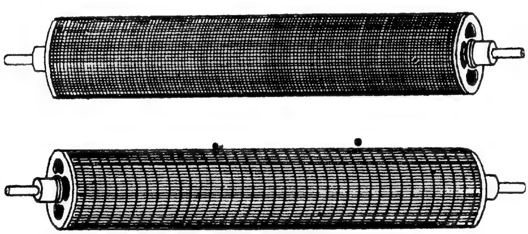


FIG. 45.—Dandy-rolls for Wove (the upper one) and Laid Paper.

percentage of the added loading, and is therefore caught in a box and pumped into the entering pulp before it reaches the sand-traps.

6. *Dandy-roll.*—This is a wire gauze cylinder, nearly 2 ft. in circumference, which revolves in contact with the wet web of pulp, and imparts to it either the *laid* or *wove* character (Fig. 45), and also any desired *water-mark*.

7. *Couch-rolls.*—The wet web of paper is pressed between two rolls, one covered with felt, and becomes more compacted. It is then carried on an endless sheet of felt to the press-rolls.

8. *Press-rolls.*—These carry the process of felting and compacting still further by subjecting the sheet to considerable pressure.

9. *Drying-cylinders.*—These are large, hollow cylinders heated internally by steam, and they serve to deprive the paper of a great deal of its moisture. They may number from twelve to over thirty.

Finishing Operations.—The best qualities of machine-made paper are taken from the machine after passing over the drying-cylinders and tub-sized by being passed through a bath of gelatine or glue. They are then hung up in long festoons and subjected to a current of dry air, in which they are slowly dried so as to produce the so-called *loft-dried papers*.

As a general rule the sizing and drying of tub-sized papers are carried out in a separate machine. The paper as reeled from the paper-making machine is allowed to lie for some time until it becomes quite cold. It is then taken and unwound through a vat containing the gelatine size, after which it is dried off by being carried over a large number of skeleton cylinders made of light wood. Inside these cylinders, revolving rapidly in the opposite direction to the travel of the paper, are a number of fans. By this means the size is dried on the surface of the paper, so producing a uniformly sized sheet, which is then calendered and cut off in the usual way.

Many papers are submitted to the process of *super-calendering* in order to give them a highly finished surface. The paper before being wound up on the paper-making machine is treated with a very fine spray of water. This slightly damped paper is then put through what is called a *super-calender* (Fig. 46). This consists of a number of rollers alternately of steel and compressed cotton. The pressure and friction that the paper is here subjected to produce a highly polished surface, the polish obtained being dependent upon the amount of spray put on at the machine as well as the amount of pressure applied. The *friction-glazing machine* will give an even finer finish to the surface of paper than the super-calendering machine. It is similar to the super calender, but the cotton rolls are large and the steel ones small. The reel of finished paper, after calendering, is cut by a machine called a *cutter* into sheets of the desired size.

Art Papers.—In order to make a paper suitable for printing half-tone blocks so as to bring out all the detail clearly, it has to be coated with a suitable mineral substance and then polished in the super-calender.

The minerals used for this purpose are *China clay*, *satin white*, and *blanc fixe*, which are fixed on the paper by means of a solution of glue or casein. Satin white is chemically calcium sulphate, calcium carbonate, and alumina, and is prepared by the interaction of sulphate of alumina on quicklime. Blanc fixe is barium sulphate. If casein is used as the sizing medium, borax or ammonia must be used as a solvent, as casein is insoluble in water. The mineral coating is applied to the paper in a *coating machine*, consisting of three parts, viz., the coating

machine proper, a drying machine, and a reeling machine. Each side of the paper is usually coated separately. The effect of adding this coating is to increase the weight about 30 per cent, but the bulk is in no way increased, that is to say, sixteen pages of the paper before coating bulk exactly the same after coating.

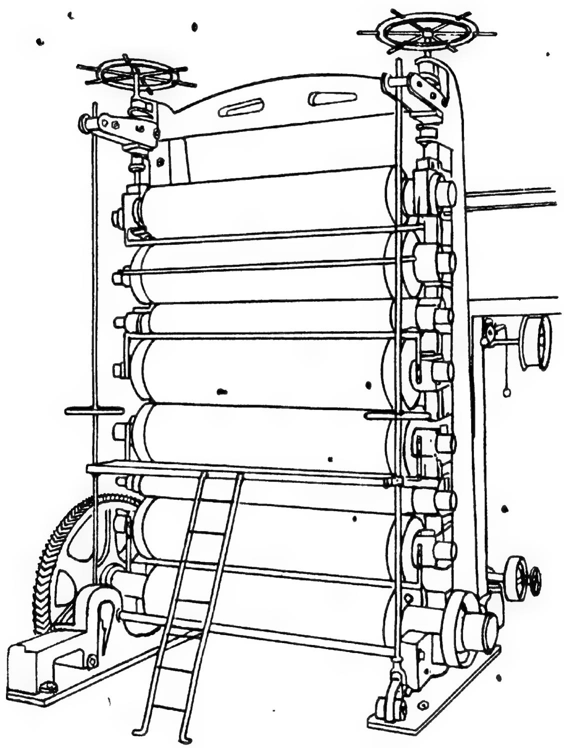


Fig. 46.—A Super-calender.

The printing on an art paper takes place, of course, on the mineral coating added, but the quality of the body paper is nevertheless of great importance. It must be strong and flexible, so that the coating will not pluck away from the surface of the sheet when it is being printed. The best quality of body paper is produced from Spanish esparto with a small percentage of

chemical wood pulp. The resin used in the beating-engine and the proportion of glue used in the coating must neither be too little nor too much. If there is too little glue, the enamel peels off in printing; if too much, the ink is not properly absorbed.

Colouring substances may be introduced into the coating mineral so as to produce a coloured art paper. If a different colouring substance is used for the two sides, a *duplex paper* is the result. *Imitation art paper* is a heavily loaded and lightly sized paper wetted on the surface before passing through the calender rolls of the paper machine. It serves in place of art papers for some purposes, but it has a poorer surface and is usually less durable.

Mixing of Pulps.—In paper-making pulps of different kinds are frequently mixed, different mixtures being used for different purposes. Ordinary newspapers are usually printed on paper made from a mixture of mechanical wood pulp and chemical wood pulp, the former greatly predominating. A chemical pulp prepared with soda, either unmixed or mixed with esparto pulp, is very suitable for soft papers of considerable bulk, such as blotting papers and antique papers. A bleached sulphite pulp mixed with esparto or rag pulp yields an excellent paper for lithographic purposes.

Physical Qualities of Paper.—A few notes on various physical qualities of paper will be helpful to the lithographer.

1. *Weight.* The weight is expressed by giving the weight of a ream, the ream consisting of 480 sheets, or more usually in ordinary printing papers, 500 or 516 sheets. Thus we may speak of a paper of 40 lb. demy, meaning that a ream of demy size weighs 40 lb.

2. *Bulk.* The bulk of paper is indicated by giving the thickness of a ream or the thickness of a single sheet, the latter being measured by a micrometer gauge. The bulk depends upon the kind of pulp used, and also upon the process of manufacture. Cotton rags yield a bulkier paper than any other material, and esparto comes next in this respect. The longer the pulp is beaten, the thinner the resulting paper. The calendering and glazing rolls greatly reduce the bulk of a paper.

3. *Transparency.* Some fibres yield a more transparent paper than others, and transparency is usually increased by prolonging the beating of the pulp. Sulphite wood pulp produces the most transparent papers, and after it come in order, straw, rags, esparto, soda wood pulp, jute, and mechanical wood pulp. Loading tends to opacity and super-calendering makes for transparency.

4. *Strength.* This is variously indicated and measured. It may be expressed by the weight required to break a definite

strip, called the *breaking strain*, or by the pressure required to burst a sheet fixed horizontally, called the *bursting strain*. The strength of a machine-made paper is greatest in the *machine direction* of the paper, that is, in the direction of flow of the pulp in the paper-making machine.

5. *Stretch*. This denotes the elongation of a paper under tension, and is important from a lithographic standpoint. A paper stretches least in the machine direction, and most in the direction at right angles to the machine direction. To find the machine direction of a paper, when it cannot be deduced from the appearance of the fibres, place a circular piece of it on water so as to wet only the under surface. Then lay the piece on the back of the hand. It will curl round into a sort of tube whose length runs with the machine direction of the paper.

6. *Resistance to Folding and Wear*. These are qualities of great importance for various kinds of paper, and may be tested empirically in several ways.

Paper and Moisture.—An ordinary paper usually contains from 4 to 6 per cent of moisture, the amount varying according to the humidity of the atmosphere. If a paper with little or no moisture is exposed to the air, it will gradually absorb moisture and therefore increase in weight. The expansion of the fibres in this way may result in creases, and these naturally cause trouble to the printer. A pile of sheets may become wavy at the edges through the absorption of moisture there. All paper for printing, especially for lithographic printing, must be *matured*, that is, exposed freely to the air so as to absorb the maximum of moisture throughout its whole substance. This subject will be more fully dealt with in Chapters XXII and XXIII.

Lithographic Requirements in Paper.—Paper for lithographic printing should be carefully made, and special precautions should be taken in the preparation of the pulp to ensure the minimum of stretch during printing. The best quality of litho paper is made from esparto, but sulphite pulp is often mixed with the esparto pulp. To obtain the best results, the esparto half-stuff should be beaten quickly and cut up with sharp tackle so as to produce an open pulp, easily drained and dried on the paper machine. Such a pulp does not shrink much in drying, and expands very little in printing. From the wet to the dry end of the paper machine the tension on the web of paper as it is being gradually dried off should be as little as possible, and the felts which keep the paper in contact with the drying-cylinders must be tight, so as to prevent "cockling" in the finished sheet. In order that the sheets may expand the correct way when printing, the paper should be run the narrow way between the deckles on the paper machine. For example,

a sheet 30 × 40 in. should be run the 30-in. way across the paper machine, and put into the printing machine the broad way.

When the paper has been reeled off the machine, it is of advantage from a lithographic standpoint to have it damped and super-calendered. This not only gives a smooth finish, but also takes the stretch out of the paper, and so fits it for work in which very fine register is necessary.

Enamelled or art paper for lithography should be specially prepared for the purpose, because the highly finished art papers commonly supplied for letterpress work are unsuitable for litho printing. The coating should be free from the substance called satin white, and the mill should be given clearly to understand that the paper is for lithographic work. Colours will print lighter and purer on enamelled (or coated) papers than on plain uncoated papers, and for work that is to be varnished the best results are also obtained on this class of paper. A good esparto-pulp super-calendered paper of about 60 lb. weight demy will produce more artistic results than can be obtained on enamelled papers.

Litho paper must be absolutely neutral, that is, neither acid nor alkaline in its reaction with litmus. An acid or an alkaline paper will gradually destroy the work. If the paper or the coating is suspected of affecting the work by containing either acid or alkali in its composition, a piece should be torn up and boiled with distilled water, when it may be tested for acids or for acid salts by dipping into the solution a piece of blue litmus paper. The paper will turn red if acids are present. If no change takes place in the colour of the litmus paper, then make a test for alkali by using *red* litmus paper. If alkali is present, the red litmus paper will turn blue.

Standard Sizes of Writing and Printing Papers.—The following tables give the standard sheet sizes of writing and printing papers respectively:—

WRITING PAPERS.

Sizes.	Dimensions. Inches.
Large Post	$16\frac{1}{2} \times 21$
Foolscap	$13\frac{1}{4} \times 16\frac{1}{2}$
Pinched Post	$14\frac{1}{2} \times 18\frac{1}{2}$
Post	$15\frac{1}{4} \times 19$
Demy	$15\frac{1}{2} \times 20$
Medium	18×23
Royal	19×24

Printing Papers.

Sizes.	Dimensions. Inches.
Demy	$17\frac{1}{2} \times 22\frac{1}{2}$
Double Crown	20×30
Royal	20×25
Double Foolscap	17×27
Double Demy	$22\frac{1}{2} \times 35$
Double Royal	25×40
Imperial	22×30
Super-royal	21×28

From the above tables it is easy to calculate the dimensions of any sheet in any of the folds, whether folio, quarto, or octavo. Thus the demy sheet, $17\frac{1}{2} \times 22\frac{1}{2}$ in., gives demy folio, $17\frac{1}{2} \times 11\frac{1}{4}$ in., demy quarto, $8\frac{3}{4} \times 11\frac{1}{4}$ in., and demy octavo, $8\frac{3}{4} \times 5\frac{5}{8}$ in. Super-royal octavo represents a size of $10\frac{1}{2} \times 7$ in.

01 **Standard Sizes of Cards.**—The following table shows the standard sizes of cards:—

Sizes.	Dimensions. Inches.
Thirds	$3 \times 1\frac{1}{2}$
Extra Thirds	$3 \times 1\frac{7}{8}$
Reduced Small	$3\frac{9}{16} \times 2\frac{1}{8}$
Small	$3\frac{9}{16} \times 2\frac{7}{16}$
Town Size	3×2
Carte de visite	$4\frac{1}{8} \times 2\frac{1}{2}$
Large	$4\frac{1}{2} \times 3$
Correspondence	$4\frac{1}{2} \times 3\frac{1}{2}$
Large Court	$4\frac{7}{8} \times 4$
Double Small	$4\frac{7}{8} \times 3\frac{9}{16}$
Double Large	$6 \times 4\frac{1}{2}$
Cabinet	$6\frac{1}{2} \times 4\frac{1}{4}$
Quadruple Small	$7\frac{1}{8} \times 4\frac{7}{8}$
Quadruple Large	9×6

CHAPTER XV.

THE THEORY OF COLOUR.

Light and Colour.—Colour is a property of bodies which is manifested only in the presence of light. In complete darkness there is no distinction of colour, and in a dim light all colours appear to be more or less alike. The colour of a body is, in fact, due to a kind of selective action it has on the light that falls upon it. The exact nature of this action is completely unknown, but its results are matters of daily observation. Why a violet is blue or sulphur yellow we cannot say, but we know that each derives its colour by absorbing certain elements from white light and reflecting others.

The Nature of White Light.—A simple experiment, first made by Sir Isaac Newton more than 200 years ago, will prove that the white light of the sun, either direct or diffused as daylight, is a combination of many colours. Darken a room completely by covering the windows with shutters, and pierce a small hole through one of the shutters. A beam of light will pass across the room from the hole and light up a spot on the opposite wall, its path being more or less traceable owing to the presence of dust particles in the air. If a triangular glass prism is placed in the path of the beam, as shown in Fig. 47, the light in passing through the prism will be *refracted*, that is, it will have its direction changed so that it will strike the opposite wall at a different height. Not only so, but instead of a bright spot of white light the wall will show a band of coloured light, with colours arranged in series like those of the rainbow, namely, red, orange, yellow, green, blue, indigo, violet. The rainbow, indeed, is caused by refraction of sunlight in a similar way. White light is thus shown to be composed of a number of varieties of coloured light, which are refracted to different extents, the red being the least refrangible and the violet the most. The coloured band of light produced as above is called a *spectrum*, and the colours of the spectrum can be re-combined to form white light.

The Spectrum of White Light.—The colours of the spectrum are usually given as seven in number, namely, red, orange, yellow, green, blue, indigo, violet, and are easily remembered by

the fact that the initial letters in the reverse way form the pronounceable word *vibgyor*. They are, however, not sharply distinguished, but gradually shade into each other, and a more exact enumeration would be: red, orange-red, orange, orange-yellow, yellow, greenish-yellow, green, bluish-green, cyan blue, violet-blue, violet. More than half the spectrum is taken up with the blue and the violet, nearly a quarter is covered by green and yellow, and about a fifth by red and orange. All the spectrum colours are pure, that is to say, if any one is isolated and passed again through a glass prism, it will not split up into any other colours.

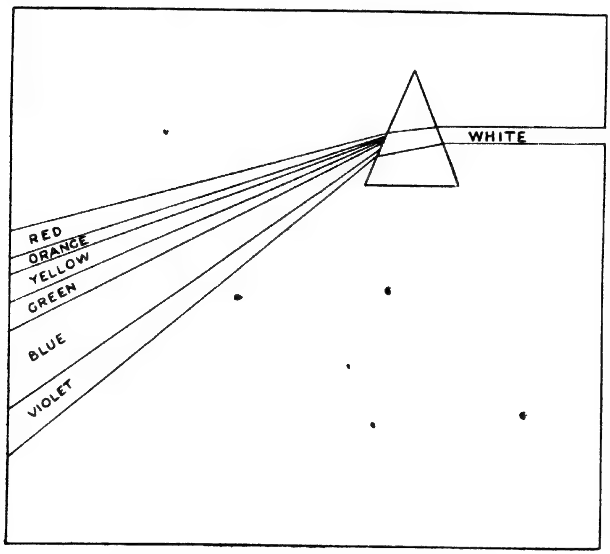


FIG. 47.—Analysis of White Light by a Prism.

Coloured Bodies.—A coloured body owes its colour to the absorption or suppression of some of the constituent colours of white light and the transmission or reflection of the others, usually more or less diminished in intensity. If we analyse the light from a surface painted with chrome yellow by means of a glass prism (mounted in a suitable apparatus called a *spectroscope*), we shall find that most of the yellow rays, a fair proportion of the green rays, and a few of the orange and the blue rays are reflected, whilst the other constituents of white light, including all the violet rays, most of the blue and the red, and

many of the green, are absorbed. The result is to give a yellow colour, but not a pure yellow like that in the spectrum of white light. This spectrum is called the *absorption spectrum* of chrome yellow. The absorption spectrum of ultramarine will show most of the blue and violet, much of the green, less of the yellow, and a little of the orange and red, no colour being entirely absent. The total result is a blue colour, but very far from the purity of the spectrum blue. The absorption spectrum of a carmine pigment is strong in the red and orange, weak in the yellow and green, and moderately strong in blue and violet, giving a total purplish effect. Indian red differs in having much less of the blue and violet, giving a brighter red colour. Coloured solutions and coloured glasses also give absorption spectra, the colours which appear in the spectra being transmitted through the media instead of being reflected from a surface, as is the case with painted bodies.

Luminosity of Colours.—An important quality of colours is luminosity or brightness. White is more luminous than any colour, and black is practically non-luminous. The colours of the spectrum are of various luminosity, the most luminous being orange-yellow and orange, next to these green and orange-red, then bluish-green and red, with the darker reds and the violets of very low luminosity. Certain quantitative measurements give the luminosity of chrome yellow as about three-fifths that of pure white, of emerald green and ultramarine, about one-half, of vermilion and umber, about one-fifth. A large extent of a colour usually appears more luminous than a small one.

Primary and Derived Colours.—For practical purposes red, yellow, and blue are regarded as the primary colours, because from pigments of these colours all other hues can be obtained by suitable mixture. If red and yellow are mixed, the result is orange, the exact shade depending upon the proportions of the two primaries. If red predominates, the orange is reddish, but if yellow predominates there is obtained an orange that inclines to yellow. A mixture of yellow and blue will give any shade of green from a greenish-yellow to a greenish-blue according to the proportions. The mixture of red and blue gives rise to purples and violets. All three primaries may be mixed together in various proportions so as to yield numerous shades of olive, sage, and brown; and even a black can be made by a mixture of red, blue, and yellow.

Orange, green, and purple, which result from combining pairs of primaries, are called *secondary colours*. These secondary colours may be combined with each other or with the primaries to produce a third series of colours called *tertiary colours*.

Thus orange and green combine to produce citron, green and purple yield a slate colour, purple and orange result in a russet hue. The mixing of a colour with more or less white leaves its hue unchanged but alters its *tint.* The more white, the lighter the tint. If a colour is mixed with more or less black, its *shade* is changed. The more black, the darker the shade.

The Mixture of Coloured Lights.—The combination of lights of different colours produces different results from the mixing of coloured pigments. If we mix a yellow and a blue

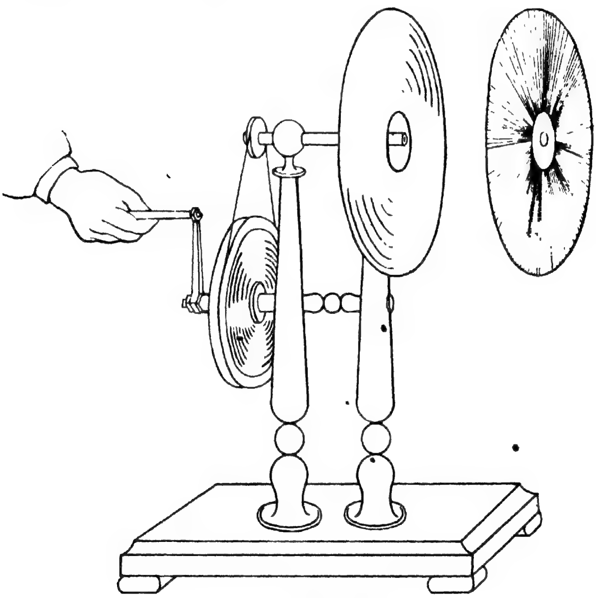


FIG. 48.—Newton's Disk.

pigment, for example, the yellow absorbs all the red and blue rays, and the blue absorbs all the red and yellow rays. The result is that all the constituent rays of white light are absorbed by the combination except green, which is transmitted or reflected by both pigments. What we obtain by the mixture is not a combination of blue light and yellow light, but the transmission or reflection of what is left of white light when its red, blue, and yellow are absorbed, namely, green.

The combination of lights of different colours can be studied

by means of *Newton's disk* (Fig. 48). This consists of a circular disk of cardboard which is made to revolve rapidly by means of a suitable mechanism. The disk can be painted in sectors of different colours, and when it is rotated the eye sees a uniform colour resulting from the combination of the colours painted on the disk. If all the colours of the solar spectrum are painted on the disk in proper order and in proper relative areas, the result is white light. If one half is painted blue and the other half yellow, the result is white (or grey, according to the shades of the primaries) and not green. Vermilion and emerald green on the disk give in combination a yellow colour, but the mixture of these pigments results in a brick red.

By means of a more exact apparatus it is possible to study combinations of the pure spectrum colours as distinguished from combinations of the impure hues of pigments. Among the results of experiments of this kind a few are worthy of note. The following five pairs of colours each combine to produce white light: red and bluish-green, orange and greenish-blue, yellow and blue, greenish-yellow and violet, green and purple. Red and green combine to produce yellow.

Complementary Colours.—In the previous paragraph we gave five pairs of colours that produce white when optically combined. These are known as *complementary colours.* Thus blue is the complementary of yellow, because a combination of blue and yellow light results in white; similarly yellow is the complementary of blue. So green and purple are complementary to each other; bluish-green is the complementary of red; greenish-blue of orange; greenish-yellow of violet.

The True Primary Colours.—The theory that red, blue, and yellow are the primary colours is not scientifically sound, but it is useful as explaining the results of mixing pigments. From the point of view of scientific optics, the true primary colours are red, green, and blue (or violet). A combination of these three colours produces white light, not black or a dark brown, as is the case with a mixture of the primary pigment colours. The secondary colours according to this more scientific system are as follows: yellow, resulting from red and green; greenish-blue or sea-green, resulting from green and blue; purple, resulting from red and blue. In each case the secondary colour occupies a position in the spectrum midway between the two primaries of which it is composed.

Contrast of Colours.—The greatest contrast in colours is between complementary pairs. Thus purple and green contrast strongly, as do yellow and blue. If two colours are seen in juxtaposition, the hue of each appears to be modified by the others. Thus if we look at a yellow and a green patch side by

side, the yellow assumes an orange hue and the green a bluish hue. So green beside blue inclines to a yellowish colour, while the blue acquires a violet tint. Complementary colours side by side intensify each other by contrast. The general principle in all such modifications by contrast may be stated thus: *If two colours of the spectrum are placed side by side, each tends to acquire a hue a stage farther away in the spectrum from the other.*

If we look intently for a time at a red object, and then direct our gaze to a white surface, we shall see a faint greenish image of the red object. If the original object is blue, the faint image will be yellow. In each case the after-image is in the complementary colour of the original. If instead of directing the gaze to a white surface after looking intently at a coloured object, we direct it to a coloured surface, the true colour of the surface becomes modified for our vision by mixture with the complementary of the colour of the first object. For example, suppose we have been looking at a blue object intently, and then turn our eyes on a green surface; the green surface will seem yellowish-green because of admixture of its colour with yellow, the complementary of blue. This is known as *successive contrast*, to distinguish it from the *simultaneous contrast* described in the preceding paragraph.

Colour Harmonies.—In all designs involving colours, the qualities of the individual colours and the harmonious combination of them must be taken into full consideration. Reds are warm colours, yellows are bright, blues and violets are cold. Red and yellow suggest nearness, whilst blue and green suggest distance. Certain colour groupings are pleasing to the eye, whilst others are harsh and displeasing. Closely related colours, such as yellow and green, green and blue, crimson and orange, make bad harmonies, but complementary pairs in proper shades usually harmonize well together. Among good and pleasing combinations we may mention the following: crimson and blue, crimson and golden-yellow, scarlet and blue, orange and blue, yellow and violet, green and red. When more than two colours are associated together, the problem of harmony becomes a much more difficult one.

CHAPTER XVI.

PRINTING INKS.

Constituents of Printing Inks.—Printing inks consist of various suitable pigments intimately mixed with linseed oil which has been boiled to a proper consistency. The mixing of the oil

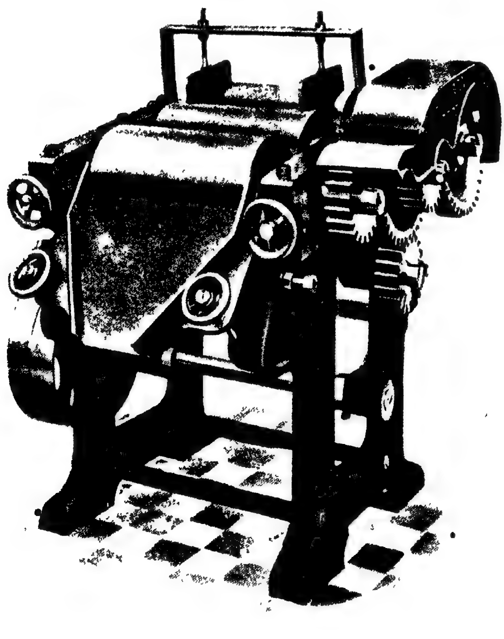


Fig. 49.—Ink-grinding Mill.

and the pigment takes place in a suitable mixing machine, and the whole is then ground between rollers in an ink-grinding mill (Fig. 49). The grinding process is continued until a fine

buttery product is obtained, which on being rubbed over with the finger sticks to it, and shows a smooth, glossy surface on the part which has been disturbed.

Linseed Oil.—Linseed oil is the chief drying oil, and is expressed from the seeds of the flax plant, which is extensively cultivated for this purpose as well as for the fibre that is manufactured into linen. The best oil for printing inks comes from the shores of the Baltic Sea, and is called *Baltic oil*, but *Calcutta oil*, as obtained from India, is not now much inferior. The oils obtained from Argentina, the United States, and the shores of the Black Sea contain impurities that render them useless to the manufacturer of printing inks.

After the oil has been expressed from the seeds, it is run into large tanks which are traversed by hot pipes, and is there allowed to settle until all the chief impurities, called *foots*, have subsided to the bottom. The oil in this state, known as *refined oil*, is sent to the printing ink manufacturer, who stores it in tanks for several months before making it into printing ink varnish. After standing in these tanks it is known as *old tanked oil.*

Boiling the Oil.—The old tanked oil is run into varnish pots containing from 40 to 100 gallons each, and it is then heated up to a certain temperature, at which it is kept for a whole day. After being allowed to cool down, it is heated to a much higher temperature, so as to cause it to thicken. It is maintained at this temperature during the day and allowed to cool over night, the heating being repeated day after day until a varnish of the proper strength is obtained. One day's heating at the high temperature will give only a very thin varnish, and each additional day's heating adds to the strength of the resulting varnish.

For certain inks and under certain conditions substances called *driers* (such as litharge, acetate of lead, etc.) have to be added to the oil during boiling. These have the effect of hastening the drying of the oil varnish when it is mixed with the pigment for printing. Under certain other conditions it is necessary to remove all the grease possible. For this purpose the oil is placed in a special kind of pot and heated until it will just light on contact with a flame. It is then allowed to burn until the requisite consistency is obtained. Varnishes made in this way are very costly and very dark in colour; consequently their use is very restricted.

Black Pigments.—*Lampblack* is the fine soot deposited when certain oils and gases are burned in a limited supply of air, so that the carbon is not oxidized to any extent. The flame plays on to a revolving metal roller, from which the soot is

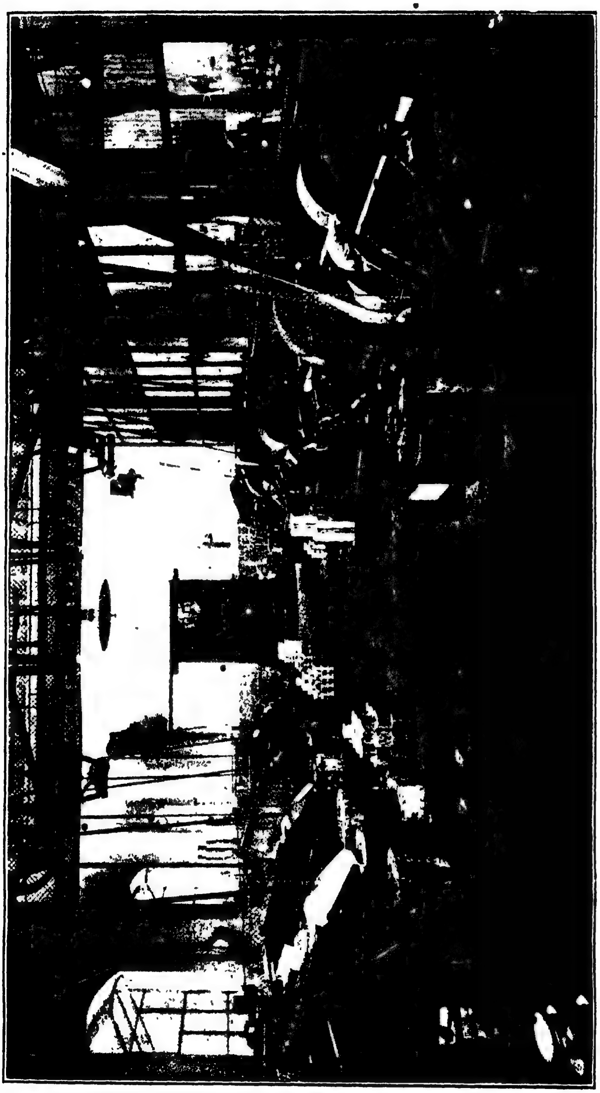


Fig. 50.—A Modern Printing Ink Factory.

removed steadily by a scraper placed on the other side from the flame. The chief grades are: *spirit black*, the most expensive, obtained from burning spirit; *carbon* or *gas black*, obtained by burning the natural gases occurring in the United States; and *common or vegetable black*, made by burning almost any oil or fat.

Frankfort or drop black is a heavy but not dense black prepared by charring wood and animal matter in air-tight kilns. *Ivory black* and *bone black* are made by charring ivory and bones in a similar manner. These char blacks are not so extensively used in the manufacture of printing inks as those mentioned in the previous paragraph.

White Pigments.—The most important white pigment is *white lead*, which consists of a mixture of the carbonate and the hydrate of lead in varying proportions, the former being the essential constituent. The hydrate is added in order to make the pigment dry more rapidly, but it tends to reduce its opacity. The oldest process of manufacture of white lead, known as the Dutch process, is still in extensive use, and may be outlined as follows. Inside a brick building or stack, some 20 ft. high, there are placed alternate layers of spent tan bark and earthenware pots, the pots containing each a piece of sheet lead on a little shelf above some dilute acetic acid. The stack is filled up in this way and left closed for some three months, during which the tan bark ferments, producing a considerable amount of heat and much carbon dioxide gas. The heat vaporizes the acetic acid in the pots and causes it to combine with the sheet lead to form acetate of lead, which is in turn acted upon by the carbon dioxide gas with the formation of white lead. The white lead of the stacks undergoes a subsequent purification to fit it for use as a pigment. There are other processes of manufacture, but it is unnecessary to describe them here.

Kremnitz white, *snow white*, and *French drop white* are produced by modifications of the process. *Flake white* is a very pure form of white lead, free from hydrate.

Owing to the highly poisonous character of white lead, various substitutes, such as *lead sulphate*, called *sublimed white lead*, and *lead sulphite*, have been introduced.

Zinc white or *Chinese white* is an oxide of zinc, prepared by burning the vapour of metallic zinc. *Zinc sulphide* is also used as a white pigment, generally mixed with barium sulphate or some other substance.

The native barium sulphate, called *barytes*, after purification, forms an excellent white pigment known as *reducing white*. Another form of the barium sulphate pigment is prepared from the *blanc fixe* or *permanent white* which occurs as a by-product

in certain chemical industries. Barium sulphate is often used to adulterate white lead.

Paris white or *whitening* is carbonate of lime, and is prepared from chalk. It is used to modify the shade of other pigments.

Alumina or transparent white is prepared by precipitating sulphate of aluminium with soda ash (i.e. carbonate of sodium), and is the chief base employed to combine with the aniline or coal-tar colours.

Blue Pigments.—*Ultramarine* occurs in nature as a rare mineral called lapis lazuli, which is found chiefly in Central Asia and China, but for commercial purposes it is manufactured by a chemical process. An intimate mixture of China clay or kaolin, soda ash, sand, sulphur, and resin is heated in a special kind of furnace and allowed to cool slowly. The blue thus formed is cleansed, levigated, and dried. Ultramarine green, red, and violet are also known, but these are not of much practical importance. A form of ultramarine is sold under the name of *Oriental blue.*

Prussian blue, also called *Berlin blue,* is a ferrocyanide of iron, prepared by acting upon the yellow prussiate of potash (i.e. potassium ferrocyanide, a compound of potassium, iron, and prussic acid) with green copperas (i.e. ferrous sulphate, one of the sulphates of iron). When solutions of these two substances are mixed together, a white precipitate is thrown down, which can be converted by oxidation to Prussian blue, the quality and shade depending on the process of oxidation. *Bronze blue, Milori blue, pure blue,* and *Chinese blue* are varieties of Prussian blue. *Antwerp blue* is a compound of Prussian blue and alumina. It should be noted that colours prepared as above are obtained in the form of a watery paste which has to be filtered and dried, and the temperature of drying greatly affects the shade of the final colour.

Cobalt blue is a very expensive blue prepared from alum, carbonate of soda, and phosphate of cobalt, but imitations are sold.

Indigo is prepared from the indigo plant, which grows chiefly in India, but it can now be chemically manufactured. Pure indigo enters into commerce in the form of blue cubes.

Electric blue and *turquoise blue* are names for blue lakes, prepared by fixing suitable aniline dyes on a base of alumina or a mixture of alumina and blanc fixe.

Red Pigments.—*Vermilion* is a very brilliant red colour consisting of a sulphide of mercury, which occurs in nature as the mineral cinnabar, but commercial vermilion is a manufactured product. The process consists in heating a mixture of

mercury and flowers of sulphur in a solution of caustic potash for several hours, but a better quality of pigment is obtained by heating mercury and sulphur together in shallow iron pans without the addition of a liquid. The best quality is *Chinese vermilion*, and other varieties include *orange vermilion*, *scarlet vermilion*, and *extract of vermilion*. *Vermilionettes* are imitations of vermilion prepared by precipitating certain of the coal-tar colours on to white mineral substances like barium sulphate or white lead. They are less permanent than true vermilion.

Red ochre is prepared by heating a naturally occurring impure hydrate of iron so as to reduce it to iron oxide mixed with such other oxides as alumina and silica. *Light red*, *Venetian red*, and *Indian red* (also called *Persian red*) are practically varieties of red ochre, differing in shade and to some extent in composition. They are manufactured as by-products of certain chemical industries.

Chrome red is a chromate of lead prepared from chrome yellow by boiling with caustic soda or lime, or by boiling white lead with a solution of potassium chromate. It appears on the market under such names as *Chinese red* and *American vermilion*.

Antimony red or *antimony vermilion* is a compound of the metal antimony with sulphur and oxygen.

Many of the red pigments are of the class called *lakes*, consisting of certain organic colouring acids combined with metallic bases, such as alumina, barium sulphate, or lead oxide. In several of these lakes the colouring acid is carminic acid, obtained from the dried bodies of the cochineal insects which live on a species of cactus plant called the cochineal fig, found in America. Of these *cochineal lakes*, as they are called, the most important is *carmine*, a very expensive colour. It contains the minimum of the metallic base, and is therefore of a rich, intense hue. *Crimson lake* contains more of the base, and *scarlet lake* owes its brighter colour to an admixture of vermilion. *Florentine lake* is another variety of carmine lake. *Bronze carmine* and *bronze scarlet* are lakes of this class with a characteristic bronze sheen.

Another group of red lakes are prepared from the root of the madder plant instead of the cochineal insect. These are known as *madder lakes*. The varieties include *crimson madder lake*, *scarlet madder lake*, *rose madder lake*, and *madder lake* simply.

Indian lake or *lac lake* is derived from lac, a resinous secretion on certain East Indian trees produced by the puncture of the lac insect, which is closely akin to the cochineal insect.

The *aniline* or *coal-tar lakes* are an important group, in

which the colouring matter is derived from the coal-tar products. The colouring principle of madder, *alizarin*, is now usually obtained from coal tar, and accordingly madder lakes really belong to this group. Other red coal-tar lakes include *orange lake*, *scarlet lake*, *geranium lake*, *red lake*, and *roseine red*, but the last name may be sometimes merely a fancy trade description.

Red lead is an oxide of lead which is used to a small extent in the manufacture of printing inks.

Yellow Pigments.—The most important yellow pigments are chromates of lead, zinc, and barium, especially of the first-named metal. These are known, according to shade, as *lemon chrome*, *primrose chrome*, *pale chrome*, *golden chrome*, *deep chrome*, *yellow chrome* or *chrome yellow*, and *orange chrome* or *chrome orange*. The lead colour is prepared by treating potassium bichromate with lead acetate (i.e. sugar of lead) or lead nitrate. Soda crystals (i.e. sodium carbonate) or Glauber's salts (i.e. sodium sulphate) may be added in order to alter the shade of the colour. *Chrome orange* and *chrome red* are made by treating lead chromate with caustic soda or lime.

Zinc chromate, sometimes called *zinc yellow* and *citron yellow*, is prepared by treating potassium chromate (not bichromate) with sulphate of zinc. Barium chromate, made from potassium chromate and barium chloride, is of a greenish-yellow colour.

Cadmium yellow, the dearest of the yellow pigments, is a sulphide of cadmium, prepared by acting on a solution of a cadmium salt with sulphuretted hydrogen gas or solution. It can be obtained in either a pale or a deep shade.

True *Naples yellow* is a compound of an oxide of lead with an oxide of antimony, but the pigment now usually sold under that name is an imitation.

Yellow ochre, also called *golden ochre* and *brown ochre*, and *raw sienna* are naturally occurring iron earths, containing an oxide or hydrate of iron along with alumina, silica, etc. The sienna is a purer and finer earth than the ochre, and usually contains a little manganese oxide. If raw sienna is heated to low redness, *burnt sienna*, which is of a more orange tint, is obtained.

Yellow lake results from precipitating quercitrin, a substance found in the bark of a North American species of oak tree, on to alumina.

The gum or resin *gamboge*, prepared from a Malaysian plant, yields a bright yellow pigment, which is most useful in the form of a lake with alumina.

Indian yellow or *purree*, made from the urine of cattle that

have been fed on the leaves of the mango tree, is very fugitive and very expensive, but a cheaper and more permanent imitation is sold under the name.

Green Pigments.—*Chrome green* consists of an oxide of chromium, but some varieties contain phosphate of chromium. *Guignet's green* is one form of chrome green, and another is known as *viridian.*

Paris green or emerald green is a compound of copper acetate and copper arsenite, but its very poisonous nature necessarily restricts its use. The ink sold now under the name of emerald green is a very fugitive lake.

Terre verte (that is, green earth) is a kind of dull green ochre which is used to some extent as a pigment.

Malachite green consists of a mixture of copper carbonate and copper hydrate, and occurs in nature as the mineral malachite.

The name *Brunswick green* is sometimes applied to a compound of copper with oxygen and chlorine, but more usually to a mixture of Prussian blue and chrome yellow combined with barytes. It is manufactured by mixing together solutions of iron sulphate, lead acetate, barytes, potassium ferrocyanide, and potassium bichromate, filtering off and drying the precipitate. This latter Brunswick green, also called chrome green, is of the nature of a lake. Other *green lakes* are prepared similarly from Prussian blue and gamboge, among them being *Prussian green* and *Hooker's green.*

Brown Pigments.—*Raw umber* is a brownish natural ochreous earth consisting of silicates of iron, manganese, and alumina. *Burnt umber,* with a darker colour, is prepared by heating raw umber to low redness.

Vandyck brown is properly a kind of bog earth containing oxide of iron, but the name is now usually applied to bituminous ochres and even to artificial preparations in imitation of them. Sometimes commercial Vandyck brown is a mixture of lampblack and yellow ochre.

Sepia is the dark brown secretion of the cuttle-fish after it has been chemically purified.

York brown is a cheap quality of brown earthy pigment. *Maroon lake* is obtained by precipitating the colouring matter of certain barks on to a mixture of alumina and lime. *Brown lake* is a name used to denote a brown pigment made from dyestuffs in contradistinction to a brown earth.

Purple, Violet, and Mauve Pigments.—Just as greens can be obtained by mixing blues and yellows, so purples can be obtained by mixing reds and blues, but there are also distinctive purple pigments. *Purple lake* is akin to crimson lake.

Burnt carmine and *burnt lake* are made by charring carmine and crimson lake respectively. A *violet lake* is obtained from the root of a species of the plant called alkanet. *Magenta lake* and *mauve lake* are lakes in which the colouring substance is respectively the magenta and the mauve obtained from coal-tar. *Mauve carmine* is a very superior and expensive quality of mauve lake.

Permanence of Pigments.—Even in the complete absence of air and atmospheric moisture, a few pigments are slightly darkened or faded by light, e.g. carmine and crimson lake. The presence of air and moisture causes more of them to be altered by light, but there are a number of colours of great permanence that show practically no change under exposure. These most permanent colours are the following: ultramarine, cobalt blue, Prussian blue, chromium oxide, terre verte, raw and burnt sienna, chrome yellow, Venetian red, Indian red, yellow ochre, burnt umber, and true emerald green. The most fugitive colours are as follows: carmine, crimson lake, purple lake, scarlet lake, mauve lake, magenta lake, violet lake, Naples yellow, emerald green lake, and indigo. In general, mineral colours are more stable than vegetable ones.

Transparency of Pigments.—Some pigments are characterized by great opacity, notably white lead, vermilion, chrome yellow, and blacks; whilst others are more or less transparent, for example, Prussian blue, ultramarine, indigo, gamboge, sepia, Vandyck brown, burnt sienna, and burnt umber. The lakes may also be classed as transparent. If in printing a show card containing bright vermilion and yellow letters with a black outline, the outline were to be printed first for the sake of register, it would be found after printing that these two colours had so obliterated the black outline as practically to ruin the work. In printing important colour work such as this, the colour sequence must be very carefully considered before commencing to print. In ordinary chromo work, after the ground has been laid with opaque colours such as chrome yellow and vermilion, only transparent colours must be used except for making tints or for outlines.

Tints, Mediums, and Pomades.—A *tint* is an ink made by adding a small quantity of strong colour to a colourless printing medium. A *printing medium* is a suitable preparation or carrier, into which may be ground a pigment of any colour, thereby forming a printing ink. Lithographic varnishes are printing mediums. A *tinting medium* is composed of litho varnish made into a transparent white ink by grinding into it such ingredients as alumina white, magnesia, starch, etc., the first being generally employed, but varnishes alone may be used.

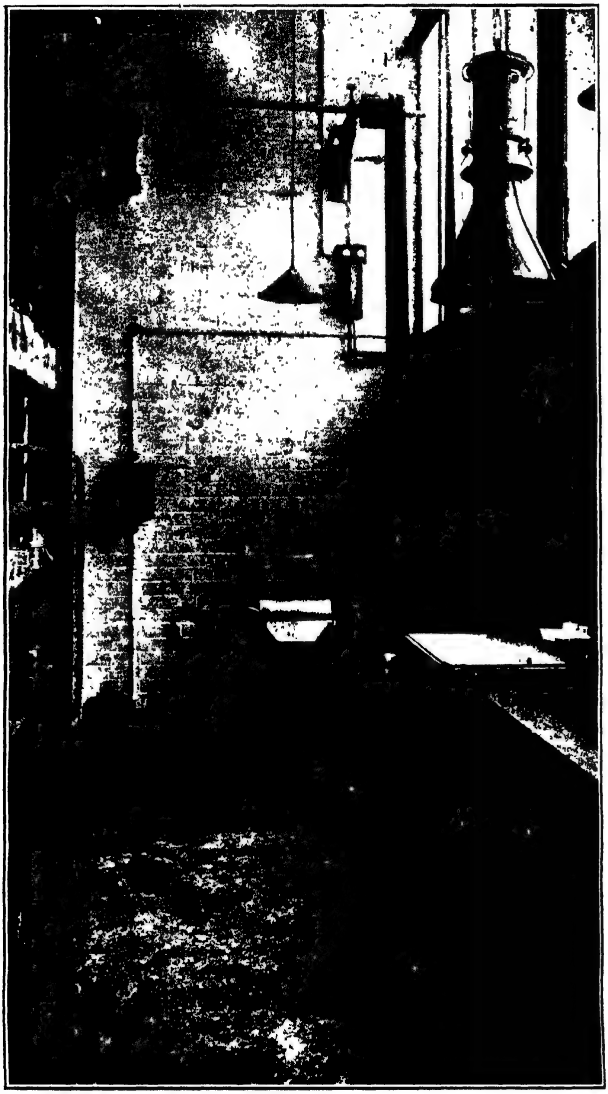


Fig. 51.—Experimental Room of an Ink Factory.

Pomade is used in printing inks for shortening purposes, that is, to make them pasty and easily workable. It belongs to the vaseline group of fats.

Drying of Inks.—Linseed oil, which is the medium of all printing inks, is a quick-drying oil, that is to say, it quickly absorbs oxygen from the atmosphere and dries to a thin, transparent film. Some pigments assist, or at least do not retard, the drying process, but others retard drying considerably. The latter require to have substances added to them called *driers*, in order to assist the absorption of atmospheric oxygen by the oil. The principal driers are *litharge* (an oxide of lead), *red lead* (another oxide of lead), *sugar of lead* (i.e. lead acetate), *gold size*, *manganese dioxide*, and *manganese borate*. The driers are often added to the oil during the boiling process described on page 132. The slowest drying inks are the lakes, lampblack, emerald green, Vandyck brown, and sepia, whilst such inks as lemon chrome, orange chrome, burnt sienna, burnt umber, bronze blue, and vermilion are quick-drying.

The Mixing of Inks.—Certain colours cannot be mixed together because of mutual chemical action. For instance, the sulphur in ultramarine will darken white lead by forming some black lead sulphide, so affecting the shade of the mixture; but zinc white can be safely mixed with ultramarine, because zinc sulphide is white. The same is true of ultramarine and chrome yellow; consequently greens are produced from the latter by the action of Prussian blue. Ultramarine is gradually destroyed by acids, and Prussian blue by alkalis.

Varnishable and Non-varnishable Inks.—When printing inks are to be varnished it is well to have a guarantee from the ink-makers that these will stand spirit varnish, this being the principal varnish used on printed work. Many of the colours used by the lithographer contain a proportion of aniline dye to give brightness, and this is apt to be affected by the spirit which the shellac, from which the varnish is made, is dissolved in. When printing with inks that are to take varnish afterwards, a quantity of gold size should be added to ensure a protective skin being formed on the work. Copal varnish is not so severe on printed work as spirit varnish, but it is much more expensive. The following list of varnishable and non-varnishable inks will be useful. Some of the names are merely makers' trade names for special shades or mixtures, rather than names of distinct pigments.

Red Lakes.

Varnishable Inks.	*Non-varnishable Inks.*
Carmine Lake	Geranium Lake
Madder Lake	Bronze Carmine Lake
Crimson Madder Lake	Ruby Lake
Scarlet Lake	Cerise Lake
Rose Lake	
Garnet Lake	
Florentine Lake	
Maroon Lake	
Brilliant Lake	

Reds.

Lake Red	Geranium Red
Pure Vermilion	
Vermilion Red	
Imitation Vermilion	
Carmine Red	
Ruby Red	
Chinese Red	
Madder Red	
Crimson Red	
Scarlet Red	

Violets, etc.

	Mauve Carmine Lake
	Violet Lake
	Mauve Lake
	Purple Lake
	Magenta Lake
	Claret Lake

Blues.

Bronze Blue	Azure Blue
Chinese Blue	Venetian Blue
Milori Blue	Turquoise Blue
Pure Blue	Electric Blue
Prussian Blue	Peacock Blue
Antwerp Blue	
Marine Blue	

BLUES.—*Continued.*

Varnishable Inks.	*Non-varnishable Inks.*
Indigo Blue	
Imperial Blue	
Blue Lake	
Oriental Blue—Light and Dark	
Royal Blue	
Ultra Blue	
GREENS.	
	Viridine Green
	Velvet Green
	Peacock Green
	Emerald Green
BROWNS.	
Photo Brown	
Chocolate	
Mahogany Brown	
Vandyck Brown	
Sepia	
Indian Red	
Venetian Red	
Raw Umber	
Burnt Umber	
Raw Sienna	
Burnt Sienna	
YELLOWS.	
Cadmium Yellow—Light and Dark	
Transparent Yellow Lake—Light and Dark	
Indian Yellow	
Naples Yellow	
Zinc Yellow	
Chrome Yellow—Primrose, Lemon, Citron, Golden, and Orange.	
Lacquers (for Tin Printing)	
Gold Lacquer	
Orange Lacquer	
Red Lacquer.	

WHITES.

Varnishable Inks.	*Non-varnishable Inks.*
Kreinnitz White	
Zinc White	
Flake White	
Transparent Tint White	
Special White (for Tin Printing	

Note.—This list will vary to some extent with different makers.

Preparation of Inks by the Lithographer.—It is very rare, nowadays, for a printer to grind his own inks, the general plan being to buy the colours direct from the manufacturer ready for use; but owing to the special requirements of the lithographer, it is the custom of the makers to supply them with as full a body of colour as possible, and stiffer than they are likely to be required. It is then a simple matter to reduce or thin them to suit all kinds and conditions of work. On the other hand, the colour which is about to be printed may be a tint only, and not a strong body-colour, in which case a very small proportion of ink is mixed into a suitable transparent medium, which takes the place of ordinary ink. This medium may be composed entirely of lithographic varnishes, such as ordinary thick or middle varnish thinned as required with thin or extra thin varnish; but it is better to use the tinting medium as sold by the ink manufacturers, thinned down to proper working consistency with extra thin varnish or boiled linseed oil.

Lithographic inks as bought in are also as free as possible from added grease, it being left to the printer to determine the amount and kind of *ink doctor* likely to be most suitable. Indeed, this could not be otherwise, as the ink manufacturer has no means of knowing the proportions of ink and medium, or anything in connection with the various jobs which the particular ink is to be used for. Nor can he know the kind of surface from which the work is to be printed: stone and aluminium require more grease than zinc.

Consistency of Inks.—Regarding the consistency of printing inks, much depends upon the quality of the paper and other conditions. To use a stiff ink upon a highly super-calendered paper would be to invite trouble from offsetting; therefore in such a case the ink must be made soft and buttery by using extra thin varnish, boiled oil, pomade, or anything that will make it short and loose, instead of stringy. The speed of the machine must also be taken into account. The quicker the speed, the greater is the necessity for *thin* inks, the general rule

being to use a very thin, short ink, with only a sufficient quantity on the rollers to print the solid portions of the work solid. The amount of body-colour is determined by these conditions. If the solids are printing solid and yet not sufficiently strong in colour, do not try to get the desired result by overloading the work with ink, but strengthen the ink by adding more body-colour to it.

Driers in Chromo Work.—The drying quality of colours must be taken into account by the machineman before beginning to print. If the work in hand is a job in which there are several printings, it will be necessary for the printer to take some precaution against the yellow—which is usually done first—drying too quickly. A second colour falling on top of one that has dried hard does not print well; neither would it print well if the first were wet and sticky. It must therefore be the aim of the printer to regulate the drying quality of the inks so that they dry neither too fast nor too slow. In printing chromo work it is a good plan to add just a little tallow or olive oil to the yellows, etc., and a little gold size or other drier to the lakes. Tinting medium is a slow-drying ink.

Printing Tints.—If the colour about to be mixed is a tint, an idea should be formed as to the quantity likely to be used, and a little more should always be allowed for. Take as much of the tinting white ink (tinting medium) on to the slab as is considered necessary to work off the job, allowing for the little extra, and thin it to working consistency with thin lithographic varnish. The colour copy should now be studied to determine which is the predominating colour, and when this has been decided upon, add this colour to the tinting medium until sufficient has been worked in to bring it up to nearly the strength of the copy. This must be tested by daubing out a touch upon paper, and then adding the other necessary colours to bring about the correct tone. For instance, if the colour about to be matched is a dark grey inclining to the blue shade, begin by adding blue to the medium, until, when a touch is daubed on paper it appears to be of about equal strength to that of the copy, only blue instead of grey. Now add sufficient burnt sienna to bring the colour round to a greenish shade, and finally add crimson lake very carefully until the correct shade of grey is obtained. It is a good practice to mix just a small quantity first, so as to form an idea of the proportions before proceeding with the bulk.

Although a grey tint may be produced by adding a small proportion of black ink to the printing medium ink, it does not as a rule produce so nice a colour as that which may be got by mixing the burnt sienna, crimson lake, and pure blue together.

It is well that the young prover or machineman should use these three colours and become as familiar with them as possible, as there is no end to the variety of shades and tones that may be made by varying the proportions, including all the shades of buffs, browns, and greys right down to a soft black.

CHAPTER XVII.

LITHOGRAPHIC PRINTING MACHINES. DIRECT FLAT-BED MACHINES.

Introductory.—Fifty years ago the only kind of lithographic machine in use was a very simple direct flat-bed type, whereas to-day there are rotary machines, offset machines, two-colour, and perfecting machines. There has also taken place during that time a very great improvement in all details and auxiliary arrangements, such as driving, inking, damping, feeding, and delivery. These developments have greatly increased the resources and widened the range of the lithographic art in competition with letterpress printing.

Although rotary litho machines are of comparatively recent introduction, the idea of such machines seems to have been in the mind of Aloys Senefelder, the inventor of lithography, for in his "Complete Course of Lithography," published in 1819, he makes reference to a "peculiar machine" which he had invented for the purpose of drawing on a "stone plate or *cylinder*". Another early inventor constructed a machine with cylinders of lithographic stone, and with inking and damping rollers.

Types of Lithographic Printing Machines.—As has already been indicated, planographic printing machines fall into two great classes: *flat-bed machines* and *rotary machines*. Each of these classes is in turn subdivided into two others, namely, *direct printing machines* and *offset printing machines*. In a flat-bed machine the printing surface is flat and travels backwards and forwards in the bed of the machine, but in a rotary machine the printing surface forms part of the surface of a revolving cylinder. Flat-bed machines can print either from stone or metal, but only metal plates are practicable in rotary machines. A rotary machine runs like clockwork, whilst a flat-bed machine is comparatively a cumbersome, noisy contrivance, with anything but a graceful movement.

In a direct printing machine the sheet is fed into the grippers of the impression cylinder, which by its revolution carries it into direct contact with the actual printing surface. In an offset machine the sheet on the impression cylinder is

brought into contact with another cylinder called the intermediate or transfer or blanket cylinder. This latter cylinder is covered with an india-rubber blanket, which receives a direct print from the printing surface, and this print is offsetted on to the sheet of paper on the impression cylinder.

In colour work, with hand feeding, the output of a rotary machine is fully half as much again as that of a flat-bed machine; and in work where register is not very important the rotary can easily do double the work of a flat-bed machine. Automatic feeding will greatly increase the rate of output.

Rotary machines take up very much less room in proportion to their printing surface than flat-bed machines. Taking a printing surface of 45 × 35 in., the following figures show the comparative dimensions of a rotary and a flat-bed machine:—

Type of Machine.	Length.	Breadth.	Height.
Flat-bed	17 ft.	9 ft. 6 in.	7 ft. 3 in.
Rotary	12 ,,	9 ,, 10 ,,	6 ,, 6 ,,

The floor area covered by the flat-bed machine is, therefore, 161½ sq. ft., whereas the equivalent rotary machine occupies only 118 sq. ft., or fully 25 per cent less.

The Direct Printing Flat-bed Machine.—As the oldest type of litho printing machine, and as exemplifying much that is common to all types, the direct flat-bed machine will be described first, and at greater length than the remaining types. The essential parts of the machine may be enumerated thus (see Fig. 52): (1) the *frame*; (2) the *carriage*, for receiving the stone or iron bed-plate; (3) the *impression cylinder*, round which the sheet of paper passes in order to receive the impression from the printing surface; (4) the *driving mechanism*, for propelling the carriage, revolving the cylinder, etc.; (5) the *inking mechanism*, for inking the surface of the stone or plate; (6) the *damping mechanism*, for damping the surface of the stone or plate; (7) the *feeding mechanism*, for supplying the sheets of paper to the impression cylinder; (8) the *delivery mechanism*, for taking the printed sheets off after they have received the impression. All these eight parts of the machine will now be described in succession, along with various details associated with them.

The Frame.—The frame of the machine must be very strong and rigid, because the whole of the strain ultimately falls upon it. It consists of two strong iron *side frames*, joined by cross stays. The *centre stay*, which should be placed exactly under the centre of the impression cylinder, in order to take the

full weight of the impression, must be firmly bolted to the side

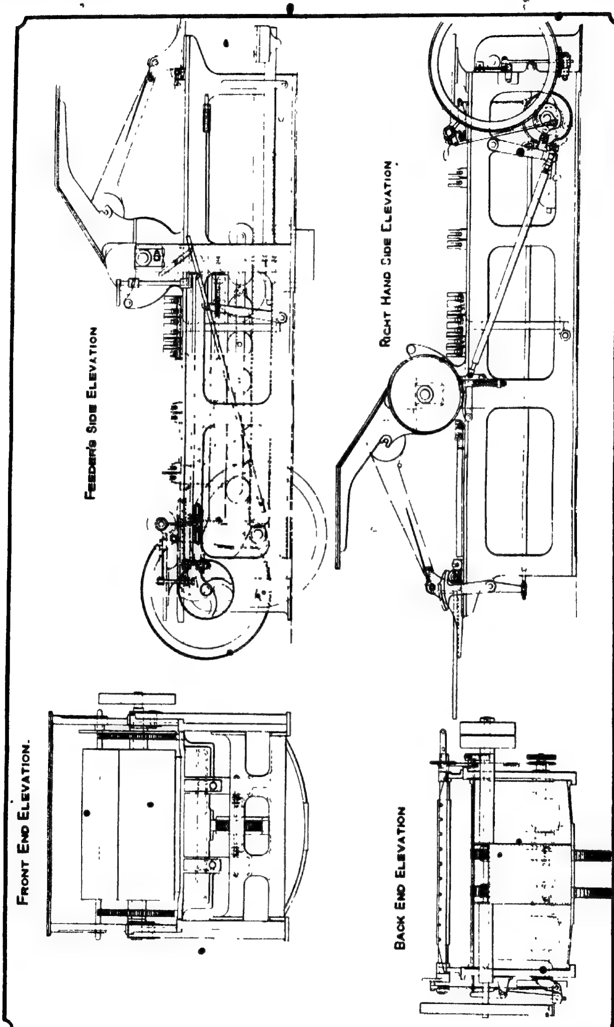


FIG. 52.—Four Views of Direct Flat-bed Machine.

frames. It is a good plan to grout it into the foundation with concrete, or to pack it up with hardwood wedges, thus rendering

it impossible for any spring to take place. The front and back stays serve as ties to the side frames, and the latter also carries the journals for the bearings of the driving shaft.

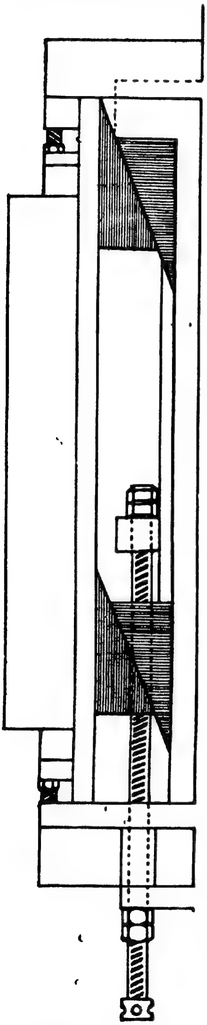


Fig. 53.—The Stone Carriage, with Arrangement for Raising and Lowering the Stone or Iron Bed-plate.

The Carriage.—Resting upon and bolted to these three stays are the *runner rails* upon which the carriage reciprocates, that is, moves backwards and forwards. These rails must be very accurately finished, and must be strong enough to prevent any dip from taking place. The carriage rests upon a number of pairs of *runner bowls* or *anti-friction rollers*, which roll backwards and forwards on the runner rails. These rollers must be ground accurately to limit gauges, so as to ensure that they are all of the same diameter, for if there is any difference in the diameters the carriage will rest only upon those of largest diameter.

The carriage itself is sometimes referred to as the *coffin* because of its shape. It consists of a bottom enclosed by four sides, all very strong, and the coffin-like shape is intended to make it suitable for being fitted with a movable bed, whose position in the carriage can be adjusted to suit the thickness of any particular stone or iron bed-plate for metal plate printing. This adjustment is effected as follows (Fig. 53). At the bottom of the coffin there are wedge pieces upon which rest corresponding inclines on the underside of the movable bed. Projecting through the carriage at its front end, and attached to the wedges, there are screws, by means of which the wedges are drawn forward or pushed back, thus raising or lowering the bed so as to bring the stone into correct contact with the cylinder.

The Impression Cylinder.—The impression cylinder is of iron ground perfectly true, and is of massive construction. It is mounted on a solid steel shaft of good diameter in order to withstand

the great pressures required in lithographic printing, and this shaft is journalled in bushes of cast iron or gun metal, which are let into the side frames.

Two methods of adjusting the pressure of the cylinder on the printing surface are in use, namely, the *lever system* and the *spring system*. In the former (Fig. 54) there are two links attached to the underside of the cylinder bushes. These hang down in the box portion of the frames, and there rest on them two long

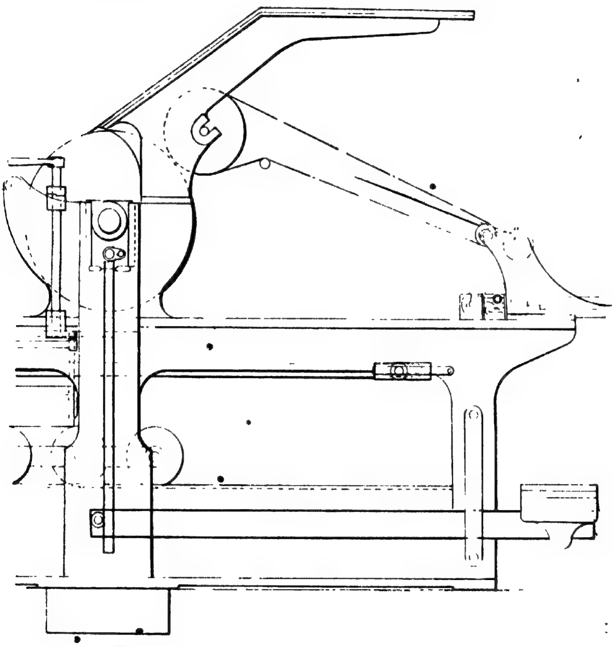


FIG. 54.—Lever System of Obtaining Pressure.

bars parallel to the base of the machine. At the ends of these bars there are cast-iron weights, which can be varied in number according to the pressure required. In setting the stone the movable bed should be raised until the stone, when passing under the cylinder, just slightly lifts the weights. In the other system (Fig. 55) there are powerful springs bearing down on the bushes, and the pressure is regulated by means of screws. The means of fixing these screws varies in different machines. Messrs. Furnival & Co., Ltd., adopt the lever system, but other makers employ the spring system.

Driving the Carriage.—The *driving shaft,* which is journalled on the back stay, is revolved by a belt from the power shaft, the belt operating on the usual fast and loose pulley arrangement, or it may be driven by an electric motor. On the other end of the driving shaft from the fast and loose pulleys there is a large flywheel. On the centre of the driving shaft there is a pinion wheel, or more usually *two pinions,* gearing with large *spur wheels* set low in the frame of the machine. These spur wheels, which are on the same shaft, are coupled together by a *crank pin,* which supports and controls one end of the *connecting rod.* The other end of this connecting rod is forked with a short shaft or stud journalled in each side, which carries a *rack wheel* for propelling the carriage. The reason for forking this end of the connecting rod is to support the rack wheel at each side, so as to make it strong enough to propel such a heavy carriage as is required in a lithographic machine. On its lower side the rack wheel is in mesh with a *fixed rack* attached to the centre stay, whilst on its upper side it is in mesh with a rack attached to the underside of the carriage. Accordingly, as the spur wheels revolve, the rack wheel is moved backwards and forwards along the bottom rack, and as this rack is fixed the rack wheel is thereby caused to revolve, thus propelling the carriage backwards and forwards by its action on the upper rack. In one of the machines afterwards illustrated the propulsion of the carriage is effected by a hypocycloidal mechanism.

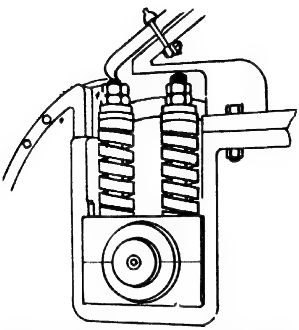


FIG. 55.—Spring System of Obtaining Pressure.

Driving the Cylinder.—On top of the carriage and attached to it are two racks, one at each side, which are in mesh with two spur wheels on the cylinder shaft, one at each side. The wheel on the off side of the cylinder is called the *fast wheel,* because it is fixed to the cylinder shaft so as to revolve with it; the other, called the *loose wheel,* revolves freely on the cylinder shaft at the feeder's side. The loose wheel, being always in mesh with its rack, oscillates as the carriage reciprocates, and keeps the cylinder and carriage always in proper relation to each other. The fast wheel has several teeth cut away so as to avoid meshing with its rack

when the carriage is reversing. The cut-away portion is so timed as to come opposite to the rack at the end of its stroke, thus allowing the carriage to return while the cylinder remains stationary for the grippers to receive the next sheet.

The Cylinder-starting Arrangement.—The loose wheel starts the cylinder and turns it until the fast wheel comes into mesh with its rack, the mechanism for securing this being as follows (Fig. 56). Having its bearing in the end of the cylinder there is a swivelling pawl which has a tail-piece in engagement with a spring stud, whose pressure keeps the pawl in its normal position. Hanging loosely on the cylinder shaft, on the outside of the loose wheel and revolving with it, there is a link having at its end a projection which protrudes through a radial slot in the loose wheel. This link is held against one end of the slot by means of a spring attached to the loose wheel, on the inside of which there is a lug against which rests the projection of the link. When the cylinder has completed a printing revolution, the carriage reverses, thereby changing the direction of revolution of the loose wheel and leaving the cylinder stationary. The lug on the loose wheel then comes into contact with the pawl, compresses the spring, and so allows the lug together with the projection on the link to pass. The travel of the carriage is so arranged that the projection goes just beyond the pawl, and the removal of the pressure on this allows the spring stud to swivel it into its normal position once more, so that when the carriage again reverses, the projection and lug come against the pawl, and the cylinder is revolved into contact with the printing surface.

If these parts were working always in the relation described, the cylinder would take every time, but as this is not desirable a check action is provided which is operated by a handle on the outside of the side frame, convenient to the feeder or layer-on. This handle is attached to a stud which connects, on the inside of the frame, to a cross piece which, when in one position, allows the different parts to operate so as to revolve the cylinder; but when it is desirable to check the cylinder, the handle is moved so as to bring the cross piece into such a position that when the loose wheel is reversing it stands in the path of the projection on the link, so preventing it from following the lug on the loose wheel. Under these conditions the lug on the loose wheel presses down the pawl, but the projection on the link not being able to pass with it holds the pawl down, and thus when the wheel again reverses, the lug on the loose wheel passes over the pawl, leaving the cylinder stationary.

A Double-inking Mechanism.—On the check handle there is a tail-piece, at the end of which there is a stud engaging

with a bar attached at its other end to a stud in a wheel which is in mesh with a pinion of half its diameter, keyed to the spur

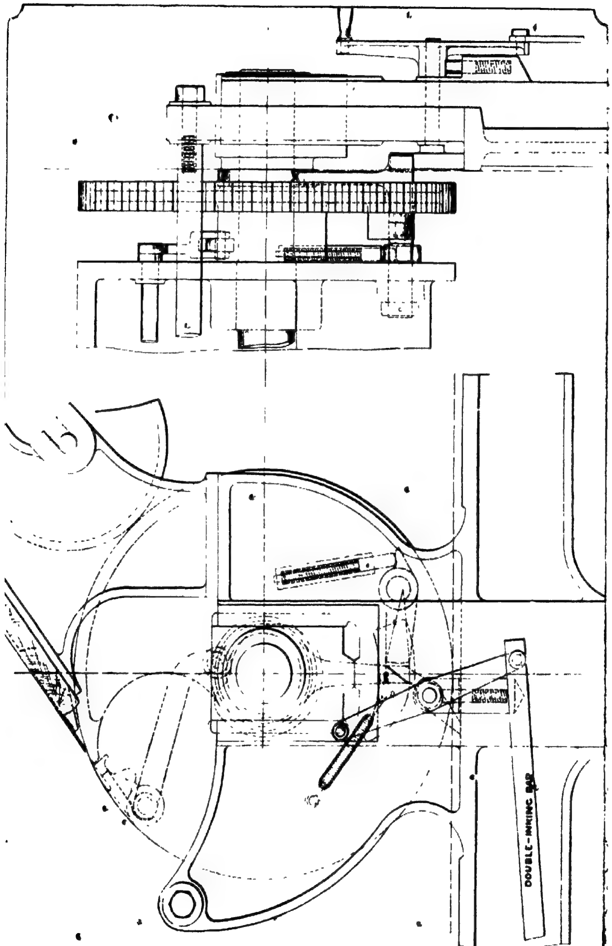
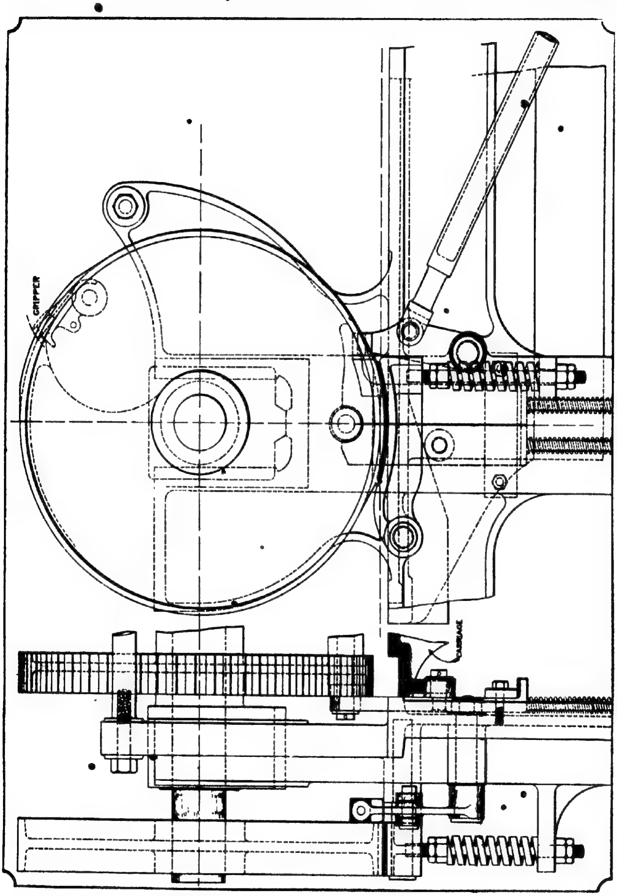


Fig. 56.—Cylinder-starting Arrangement.

wheel shaft. As the spur wheel shaft and the wheel on it only make one revolution to each complete cycle of the machine, it follows that the wheel in mesh with it, being twice its diameter,

only makes one revolution to two cycles of the machine. Therefore this wheel through the bar pushes the check handle over at every second cycle of the machine, thus causing the



cylinder to be taken every other time, and so double-inking the stone. The bar is slotted so that it may be easily removed, and it is attached only on those rare occasions when double rolling is necessary.

The Cylinder-locking Arrangement.—The fast wheel of

the cylinder is fitted with a locking arrangement which, in conjunction with the *push-home rod*, ensures that the cylinder will come to rest at exactly the same place each time (Fig. 57). On the insides of the side frames, sliding vertically, there are two bars which are held in their top position by springs underneath. These together form what is termed the *lock-bolt*. At the top they are cut away so that together they form a cup, and one of them also has a shoulder or cam piece on to which runs a bowl attached to the fast wheel, the contact causing the spring underneath to compress and so allow the bar to drop. The carriage at this point having arrived at the end of its stroke, the cylinder is pulled up by means of the brake, the bowl resting on the bar until the cylinder is pushed home, which is accomplished in the following manner. Swivelling on a stud in the side frame there is a lever on which is a bowl in contact with a cam on the spur wheel shaft, and attached to this lever there is a rod, at the other end of which is the push-home lever, also swivelling on a stud. The latter lever, through the action of the cam, swivels backwards and forwards and comes in contact with a lug on the brake wheel (fixed to the cylinder shaft), thereby pushing the cylinder home, that is to say, pushing it until the bowl on the cylinder wheel rests in the cup formed by the two bars, the one on which the bowl has been resting immediately rising behind the bowl when it has passed into the cup. In this way when the pushing lever recedes the cylinder is held in a given position until the loose wheel engages with it, when an incline on the underside of the carriage comes into contact with a bowl fixed to the bar or lock-bolt against which the cylinder has been pushed, forces it down, and allows the cylinder to revolve.

The Furnival Cylinder Brake.—In Furnival machines the cylinder is fitted with a powerful *swivel brake* (Fig. 58) whose engagement and adjustment with the brake wheel are regulated by means of a powerful spring on the underside. On the brake wheel there are two swellings which, as the cylinder revolves, run on to the brake shoe, thereby compressing the spring, whose pressure effectually controls the cylinder. The pressure of the spring is regulated by means of a screw and nuts. One of the swellings is so placed that it runs on to the brake shoe just before the carriage has finished its stroke, and remains in contact until the cylinder has again commenced to revolve, thereby not only slowing down the cylinder but, together with the lock-bolt, keeping it

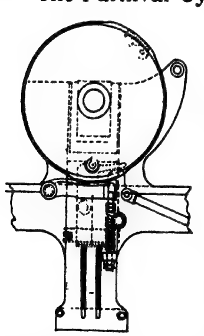


FIG 58.—The Furnival Cylinder Brake.

under complete control. The other swelling is so placed that as the cylinder revolves and approaches its contact with the printing surface, it runs on to the brake shoe and remains in contact until the friction between the stone and the cylinder is effective, after which it once more runs free. The effect of the brake at this point is to stagger the cylinder gear in the rack so that the cylinder still meets the stone at exactly the same place each time.

Other Cylinder Brakes.—Other methods are adopted by different makers to obtain the same results. Fig. 59 shows the brake on a machine of Mann & Co. It consists of a shoe in two portions, the upper parts of which are drawn more or less close to the brake wheel by means of connecting rods with a pressure wheel in the centre. This pressure wheel rests upon an eccentric cam, which, while revolving, pushes it up, causing the shoe to tighten and grip the brake wheel, releasing it again as it comes round to a lower part. Fig. 60 shows what is known as the "band" brake. It is worked by a simple up-and-down movement of the rod, thus loosening or tightening the band. The strong black lines indicate the leather facings on the shoes.

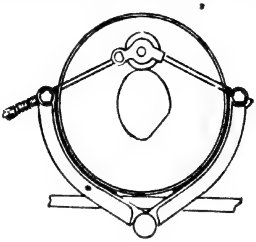


Fig. 59.—Mann & Co.'s Cylinder Brake.

Air-cushioning Cylinders.—Air-cushioning cylinders, or air buffers, are now generally employed on all lithographic flat-bed machines of large size. Their effect is to lessen the great strain put upon a machine by the action of the powerful brake, and to assist in reversing the bed. The cylinders, usually four in number, are fixed low inside the frame, at either end of the machine. A rod carrying a head at either end is fixed to the carriage. As the carriage nears the point of reversing, the head on the rod, called the plunger, enters the cylinder and compresses the air which it contains, thereby drawing up the carriage in a gentle and natural manner.

The Inking Mechanism.—The inking apparatus is a most important part of a lithographic machine. The printing surface receives the ink after it has been evenly and thinly spread by transference through contact with several surfaces, mostly of rollers. The ink is placed in an *ink duct* at the driving end of the machine, and this duct is in contact with an *ink cylinder or duct roller*, which is driven by a chain from the shaft of the large spur wheel below. This cylinder is operated by a ratchet wheel at its end engaging with a pawl, the pawl riding on a disk that

can be set so as to regulate the number of teeth through which the ink cylinder will turn at each revolution of the shaft. If the ink is to be supplied thinly, the roller is made to turn but little; if more thickly, the roller is made to turn more at each revolution. In addition there is a spring pawl revolving continuously round the end of the ink cylinder, which can, while the machine is in motion, be put into and out of engagement with a lug attached to the ink cylinder. When the pawl engages the lug, it causes the ink cylinder to revolve continuously.

The ink is taken from the ink cylinder by a *vibrating*[1] *ductor roller*, which moves backwards and forwards so as to come into

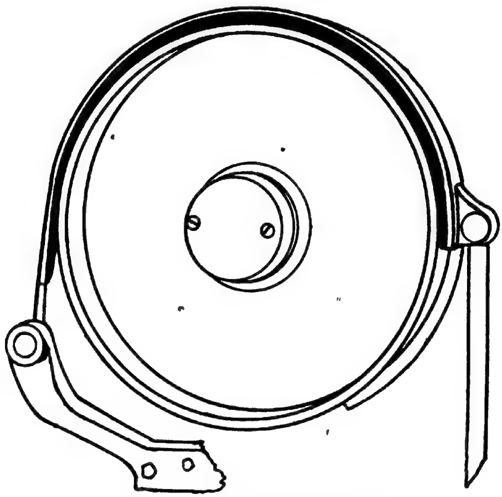


FIG. 60.—The Band Cylinder Brake.

contact with the ink cylinder and the inking slab alternately. It is operated by a cam which is so set that the roller drops on to the slab when the latter has passed well under it, and so deposits ink on the return of the carriage. The *inking slab*, which may be either of iron or of marble, is attached to the stone

[1] There is some confusion between the terms *vibrating* and *oscillating* in general use, but in this book we follow the prevailing trade practice in describing the movement of the ductor roller as vibrating and the lateral movement of some of the inking rollers as oscillating. The former is in strictness an oscillating movement, and the latter a reciprocating movement. The term vibration is more correctly applied to a very rapid oscillatory movement due to the elasticity of the moving body, e.g. the movement of a sounding tuning fork.

or plate carriage and moves with it backwards and forwards in the bed of the machine.

The inking slab transfers its ink to a number of *distributing rollers* so placed across the bed that they do not come into contact with the printing surface. The function of these rollers is to break up the colour thoroughly before it is picked up from the slab by the inking rollers. They are capable of being set at a very wide angle to give them the fullest oscillation. The *inking or forme rollers* are those that receive the evenly distributed ink from the slab and apply it to the printing surface just before it passes into contact with the paper. They may number as many as six, all journalled in separate cast-iron bushes, thereby doing away with a great deal of wear on the roller spindles and the unpleasant rattle caused by a worn spindle dancing in the fork. The inking rollers are fitted with *runners* that ride on leather-covered inclines which lead them gently on to the stone without any bump. The inclines are adjustable to suit the position of the edge of the stone. There is an arrangement for lifting the inking rollers, which is worked by means of T bars whose tops rest just below the roller bushes. These bars slide vertically inside the frames, and are raised by means of a bell crank lever, which is coupled to the lifter handle through a bar of suitable length, to allow of the handle being convenient to the operator. By means of this handle the rollers may be fixed in any one of the following three positions: (1) Lifted clear of both slab and stone; (2) in contact with slab but clear of stone; (3) in contact with both slab and stone. The distributing and inking rollers are revolved simply by friction with the slab or printing surface.

An improved form of inking mechanism includes geared reciprocating or oscillating *rider rollers* on the forme rollers. This system is very common on the Continent and also in the United States, but is not so much in use in Britain. In this arrangement the forme rollers are journalled in forks adjustable vertically, the forks being carried by blocks which are adjustable along horizontal slides. Between each two adjacent rollers, and surmounting them, there is a polished steel rider which is driven through a pinion in mesh with a rack affixed to the top of the carriage. These rollers are set in the following manner. Take the rollers out of contact with the riders by moving the fork blocks along the slide, set the stone to the correct height, and then drop the forks until the rollers rest on the stone. Having done this, raise the forks until they just touch the roller spindles, then slide the blocks until the rollers are in contact with the rider, see that the forks and blocks are locked in position, and the rollers are then ready for printing. In this

case the rollers always run in the straight, the lateral or reciprocating motion being imparted to the riders by means of bobbins on their spindles, in which a lever moves to and fro. Owing to the riders being geared, they and the forme-inking rollers are continuously revolving, whether in contact with the stone and slab or not, and therefore there is a great increase in the amount of distribution as compared with the older method.

The Damping Mechanism or Water Motion.—In a lithographic machine there must be provision for continuous damping as well as inking of the printing surface, and to ensure a uniform and not excessive damping the moisture has to reach the stone or plate through a series of rollers and a damping slab. The mechanism is very similar to the inking mechanism, but it is placed at the other end of the machine. The cloth-covered *damping slab*, like the inking slab, is part of the stone or plate carriage, and reciprocates with it in the bed of the machine. In automatic damping arrangements it receives its moisture by contact with a *vibrating damping roller*, which is in turn moistened by intermittent contact with a brass *duct roller* revolving half in a *water duct* or *water fountain*. The last-named roller is operated by a pawl and ratchet arrangement similar to that on the inking cylinder. In older machines there is no automatic mechanism for damping the slab, and water has then to be sprinkled on to it from time to time as it moves. The slab transfers its moisture to the two *damping rollers*, which in turn dampen the printing surface. The details of automatic damping arrangements vary on different makes of machines.

There is also a geared form of damper similar to the geared inking arrangements. The two damping rollers are surmounted by a polished brass roller which is driven through a pinion in mesh with a rack on the top of the carriage. The setting and adjustment of these rollers are accomplished in the same way as already described for the corresponding inking rollers. This geared damper is essential where the geared inkers are in use; otherwise the machineman will find difficulty in keeping the edges of the stone clean.

The Feeding Mechanism.—The sheets for printing on are fed to the cylinder by a feeder from a *feed-board*, of which part is flat for carrying the pile of sheets and part slopes down tangentially to the cylinder at such an angle that each sheet as placed upon it finds its way to the front rests by its own weight. The tangential position of the sloping feed-board ensures that the sheet will fall naturally on to the gripper rests without having to be forced or bent on to them by means of smoothers or guides.

The sheet is caught on to the cylinder by means of *grippers*

that close and open alternately with the revolution of the cylinder. Of these there are two kinds, the *solid plate gripper* and the *finger gripper*. The former is a cast iron piece extending the full width of the inside of the cylinder and mounted on a shaft journalled in the cylinder walls. Fastened to this cast iron portion is a flat steel plate, which is actually the gripper that nips the sheet against the edge of the cylinder. The *front lay* or *sheet rest* is a piece on the cast iron running its full length and at right angles to the steel plate. This lay may be made up of a series of small pieces which can be adjusted to suit the shape of the gripper edge of the sheet, so avoiding any risk of the sheet rocking and thereby causing bad register. The finger gripper, as the name denotes, consists of a series of fingers which can be moved along the gripper shaft to suit the position of the sheet, and the "nip" of each finger may be set individually. When the finger gripper is used, it is customary for each finger to be fitted with a sheet rest capable of adjustment to suit the amount of grip.

A *register motion* is attached to the underside of the feed board, being connected to the *side lay* through the slot in the table in which it slides. The movement of the side lay is obtained from a cam on the loose wheel of the cylinders, and is such that, when the sheet is fed to the front and side lays, the latter automatically pushes the sheet into its correct position and flies back immediately the grippers have closed upon the sheet, thus preventing the sheet from dragging against the lay when the cylinder begins to revolve. The lay is easily set for different sizes of sheet by means of a wing screw.

The Delivery Mechanism.—There are very few machines now without an automatic delivery mechanism. The printed sheet is picked off the impression cylinder on to a *delivery or flyer drum* by means of a suitable gripper mechanism, and it passes thence down sloping tapes over long parallel sticks known as *flyers*. These automatic flyers move backwards and forwards round their fixed lower ends from the tapes to the delivery board, and at each forward movement carry a printed sheet with them. An *automatic counter* may be attached for counting the sheets. There is very little risk of marking the work if the sticks are fitted either with star wheels projecting through slits or with file cards on their surface. The latter consist of cloth covered with short wires like the bristles of a brush, such as used to clean files, etc. Where finger grippers are in use, great care should be taken when adjusting them along the shaft, to see that one is not set opposite a gripper in the flyer drum, as the latter grippers cross the path of the former when opening into the gap of the impression cylinder in order to grip

the sheet and pass it on to the flyers. The flyer sticks should also be placed in position so as not to interfere with the grippers on the flyer drum.

The Machine Brake.—Last but not least, the machine is fitted with a very powerful brake, which acts on the flywheel, and is operated by means of the belt striker handle. It operates automatically as the belt is moved on to the loose pulley, and in fact when the handle is pushed home the machine is locked. The brake is so powerful that the machineman can bring the machine to a dead stop in a few inches.

CHAPTER XVIII.

MACHINE AND HAND PRESS ROLLERS.

The Different Kinds of Rollers.—All planographic machines require a considerable number of rollers, which may be classed under two distinct headings, viz. *inking rollers* and *damping rollers*. The inking rollers comprise the *forme-inking rollers*, the *ink-distributing rollers*, the *rider inking rollers*, the *vibrating ink ductor roller*, and the *ink-duct roller*. The damping rollers comprise the *forme-damping rollers*, the *vibrating damp*

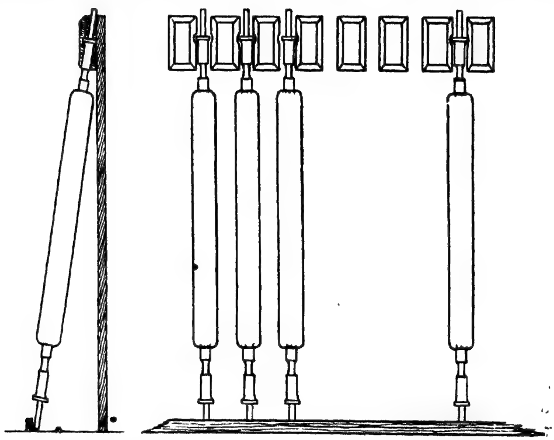


FIG. 61.—A Machine Roller Rack: Front and End Views.

ductor roller, the brass *water-fountain roller*, and the brass *damp-distributing and grease-collecting roller*.

The Forme-inking Rollers.—The forme-inking rollers are those which come into direct contact with the forme or printing surface and charge it with ink. They consist of heavy iron stocks covered with one to two plies of stout flannel and an outer covering of leather; or they may be covered with india-rubber. The flannel may be cut to the size required and then

secured to the stock by stitching, or it may be bought from dealers in the tubular or stocking shape ready to pull on. This variety is manufactured in different sizes to suit the various thicknesses of rollers. There are two different kinds of leather rollers, namely, the soft absorbent kind, and the glazed variety. The former are known as *nap rollers*, because of the soft, velvety pile on the surface; the latter are called *glazed rollers*, because of their hard, smooth surface.

Nap Forme-inking Rollers.—There are several methods of preparing nap rollers for printing. As they are received from the makers, the leather is dry and of a buff colour, but the nap is already prepared. The skins are sometimes treated first to an application of castor oil, and the rollers are then put into the machine and worked up for a considerable time with strong litho varnish, after which they are washed with turps and scraped with a blunt knife, when they are ready to receive ink. This treatment, however, has the objectionable result of causing the rollers to work greasy for a considerable time afterwards, and the leather stretches easily. A good plan with new rollers is to saturate the skins with thin lithographic varnish. A coating may be put on by spreading it over with the hand, and further applications may be afterwards given until the leather refuses to absorb more. If they are then scraped to free them from superfluous varnish, they may be put at once into the machine and charged with printing ink; but they should not be used on fine work to commence with. Nap rollers are best for all planographic work, but it is necessary to have at least four complete sets, one set for each range of colours.

Glazed Forme-inking Rollers.—Glazed rollers are prepared, if new, by placing them in the machine and running them up in thin lithographic varnish and driers such as gold size or good paste driers. When this has been well worked into the skins, the rollers should be scraped and the slab washed, after which they should be charged with a hard, quick-drying ink, such as a mixture of a yellow chrome burnt umber, and gold size. It is better to allow the roller to run in a good supply of ink until it is worked thoroughly into the grain, and then by scraping up the slab several times gradually to reduce the quantity until only the thinnest film of ink is left on the surface. The rollers may then be lifted from the machine and placed on end in the roller rack for a few days until the ink has become quite hard and dry. The surface of the rollers will now have a rough, gritty feeling as the hand is passed over them; so they must be made smooth by rubbing them with a block of wood covered with fine glass paper. The inking, drying, and glass-papering must be repeated two or three times until a satisfactory surface

has been obtained. It is not essential that the rollers should be new to do this. It may be done at any time by allowing the printing ink to dry upon them after they have been in use; but the principal point to bear in mind is to have only the thinnest possible coating on at each inking. If a short road is attempted by trying to make one thick coating do instead of several thin ones, the result will be that the ink will dry on the surface, but it may take months instead of days to become hard throughout. Glazed rollers cannot be successfully worked on metal plates; for these, nap rollers are best, with rubber ones next best. Glazed rollers, however, are very useful on stone, and allow of quick changing of colour. These rollers should be worked very sparingly charged with strong colour of thin or buttery consistency. Under these conditions long runs of good work may be carried through.

Rubber-covered Forme-inking Rollers.—Rubber-covered forme-inking rollers may be made by casting the indiarubber on to the iron stocks, and afterwards turning them true in the lathe; or they may be covered with a rubber skin pulled over a covering of flannel, and then tied at the ends exactly in the same manner as a leather roller. Rubber rollers may be used on all planographic work, whether on flat-bed or rotary machines. Their chief recommendation, however, as with glazed rollers, is the ease and speed with which they may be cleaned, and for that reason only one set of rollers is necessary for each machine. The diameter of the rollers for flat-bed machines should be exactly the same as that of the iron collars on either end of the spindles.

The Ink-distributing Rollers.—The distributing rollers, unlike the forme rollers, do not come into direct contact with the printing surface, but act on flat-bed machines midway between the forme rollers and the ink duct, whilst on rotary machines they act in conjunction with the oscillating ink drum. Their special use, as their name implies, is to distribute the ink on the slab or drum in the best possible manner previous to its deposition on the forme rollers. They should all be prepared by glazing as recommended for glazed forme rollers.

The Rider Rollers.—The rider rollers are of small diameter and made of smooth solid steel. They revolve on and between the forme-inking rollers, and there are also riders on the distributing rollers. They assist the further distribution of the ink and help to keep it in a fresh, printable condition.

The Vibrating Ink Ductor Roller.—The vibrating ink ductor roller is the one that moves to and from the ink duct, bringing with it each time a supply of ink, and depositing it on the ink slab or oscillating ink drum, as the case may be. The

quantity of ink carried is regulated by the thumb-screws at the rear of the duct and also by its dwell on the duct roller or cylinder. It is generally prepared as recommended for glazed forme rollers, and may be of either leather or felt, but it may be cast in indiarubber or printer's roller composition. The latter makes the best roller of all, but it is liable to be affected by the damp, and also by atmospheric and other conditions.

The Forme-damping Rollers.—The forme-damping rollers, like the forme-inking rollers, are those which come into direct contact with the forme or printing surface, and supply to it the necessary amount of damp to prevent the forme-inking rollers from depositing ink on the parts where it is not required. The quality and condition of the damping rollers are of the utmost importance, and this cannot be too strongly impressed upon the mind of the young machineman, as so much depends upon an even, uniform damping with the minimum quantity of water. The damping roller, as a rule, consists of an iron stock, generally (but wrongly) of very small diameter, and covered with several coverings of felt, flannel, etc., with an outer covering of a tough, hard-wearing cloth called moleskin. These rollers must be perfectly level from end to end, and of uniform thickness. It is essential that they should be kept clean and in an absorbent condition, by washing them with turps or naphtha and the scrubbing brush, and afterwards with warm water, and finally by scraping them with a blunt knife. This should be done at least two or three times a week.

More difficulty is sometimes experienced with proper damping on rotary machines than on flat-bed machines. This is largely due to the rollers continually revolving the one way, instead of reversing as on the flat-bed machine, and also to the oscillating motion of the brass distributing roller, which has a tendency to work the soft packing towards the centre, and cause them to become high at these parts. It would be better if these stocks were made of such a thickness that not more than two coverings would be required to complete them. They should be hollow to avoid unnecessary weight, faced with brass to prevent rust, and dead true.

The old idea that a damping roller built up with a number of thick absorbent coverings of felt and flannel must necessarily hold a considerable quantity of water, with which it will gradually part to the printing surface, is erroneous. This is now recognized by the machine-makers, and modern machines are fitted with automatic damping arrangements on similar lines to the inking arrangements, which give the necessary supply of damp with each traverse of the cylinder; but the makers, with few exceptions, do not appear to have seen the necessity for an

improved damping roller stock. If, however, the stock is of very small diameter and it must be built up, then let it be done with a firm, tough material that is not likely to yield or give way with the rolling, or from the effects of the oscillating brass distributing roller. Three or four ply rubber canvas cylinder covering will give this result, and there are two methods of applying the material. The first and perhaps better way is to cut off half a yard or so from the piece, which should be one and a half inches longer than the stock, and to separate one of the plies by pulling it asunder. If this is warmed slightly, it will become quite sticky, and it may then be rolled tightly round and round the stock. Now repeat the process until the desired thickness is obtained, and then tie down the ends. The roller is then completed with one ply of good flannel and an outer covering of the best quality of moleskin. This will give a roller that will remain even and regular for a long period, the moleskin being the only part requiring renewal. The second method consists in cutting the material into suitable strips (without separating the plies) and fixing it on by sewing. The thread should be well waxed, and the top ply should be treated along the seam to one or two coats of quick, hard-drying ink, when it may be finished up with the covering of flannel and moleskin. There is yet another very satisfactory method of preparing a permanently level and uniform damping roller. The stock should be sent to an indiarubber manufacturer, and the desired thickness of indiarubber composition cast on, which is afterwards turned true in the lathe as recommended for rubber forme-inking rollers. It is then finished off with the covering of flannel and moleskin.

The Vibrating Damping Ductor Roller.—The vibrating damping ductor roller acts in a similar manner to the vibrating ink ductor roller; that is to say, it moves to and from the water-fountain roller and carries with it a supply of water which it deposits in a regular fashion on to the damping slab or the brass oscillating distributing roller which runs in close contact with the forme-damping rollers.

The Water-fountain Roller.—This is a brass roller similar to the brass oscillating distributing roller, and revolves in the water fountain, the lower portion always being in the water and the top portion out of it. As it revolves, it carries round with it a uniform supply of water on its surface with which it feeds the vibrating roller. It should be kept perfectly clean, and ink and grease should not be allowed to gather on it.

Hand Rollers.—Hand rollers are prepared and treated in exactly the same manner as machine rollers. Nap rollers, whether for machine or hand, should not be allowed to lie in

colour for any length of time after being in use. The ink should be scraped from them with a blunt knife, and then washed with a mixture of three parts of naphtha to one part of paraffin oil. After scraping again the rollers may be left until required. Special precautions must be taken if driers are used in the ink.

CHAPTER XIX.

ROTARY AND OFFSET MACHINES.

Introductory.—We have already indicated the general character of rotary and offset machines, and have shown the advantage of rotary over flat-bed machines. The offset machine, which is of comparatively recent introduction, has great advantages for certain classes of work. It is only since the advent of the offset machine that it has been possible to produce perfect

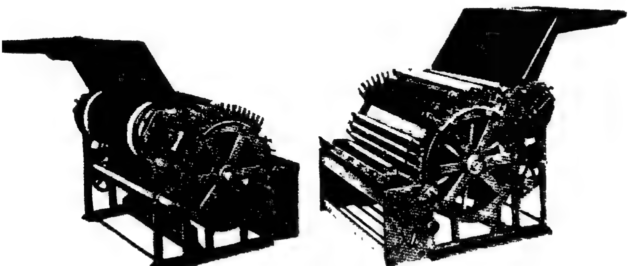


FIG. 62.—An Early Type of Rotary Machine: Two Views.

printing of the nature of a very finely engraved view, or fine unbroken hair-lines, or a smooth, sparely printed flat tint on rough hand-made paper without previously damping it, and that is done at a speed that a few years ago would have been considered impossible. Fine chromo work done on the offset machine possesses a character and charm peculiar to itself, and produces the most artistic matt effects. Less ink is required by the offset process than by the direct method.

THE DIRECT ROTARY MACHINE.

The Frame.—A direct rotary machine (Fig. 63) is built upon and securely braced to a substantial base plate. The side frames are of solid plate section and are firmly bolted to the base and suitably stayed so as to ensure absolute rigidity.

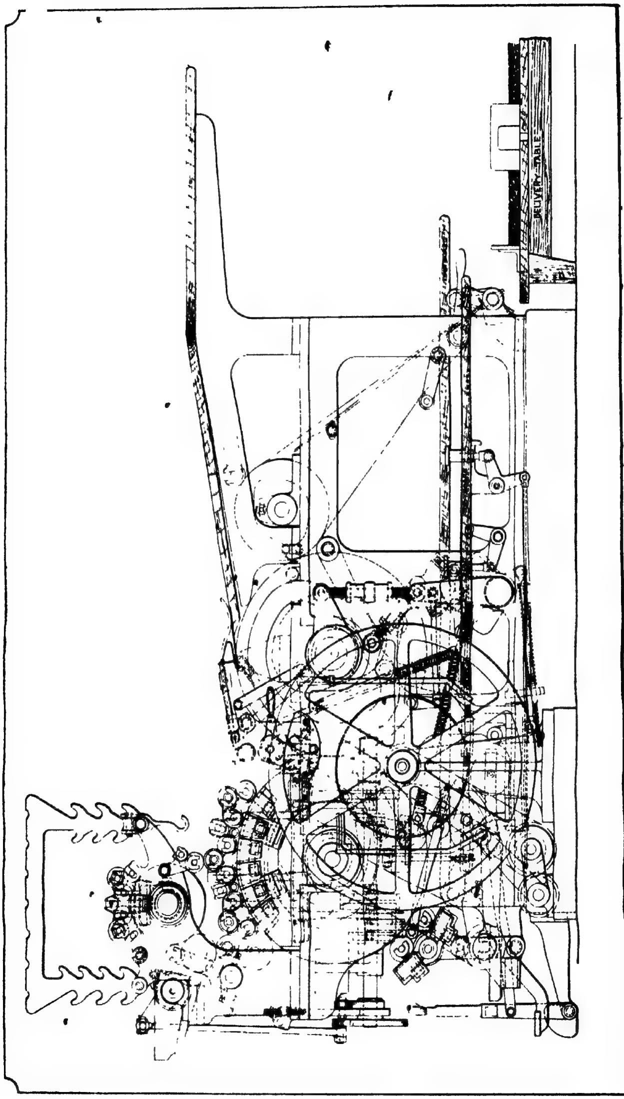


Fig. 63.—Direct Rotary Machine: Side Elevation.

The Plate Cylinder.—The plate cylinder in this type of machine takes the place of the carriage, with the stone and inking slab, in the flat-bed machine. It is ground perfectly true, and its periphery is divided into two sectors with suitable spaces or gaps between. One sector carries a permanent zinc plate which serves as the inking slab, and the other sector carries the printing plate of zinc or aluminium. The latter plate is fastened on by means of simple clamps which swivel on shafts in the cylinder gaps. These clamps are easily manipulated and enable the printer to give an even tension to keep the plate flat to the cylinder. Before putting on a plate, its back and the surface of the cylinder should be wiped so as to prevent anything from distorting the plate when the clamps are tightened.

The cylinder is mounted on a large steel shaft which is journalled in bushes in the side frames. On this shaft, at each end of the cylinder, there is a gear wheel attached to the cylinder by strong bolts which fit into radial slots in the wheels. This arrangement is very useful if the plate should be put in a wrong position, for example, out of register with the previous plate from the gripper to the back edge. In that case, it is only necessary to slacken the bolts, move the gears by means of the flywheel, and when the cylinder is in correct position to tighten the bolts again. The cylinder wheels are driven by pinions on the driving shaft, which is journalled in the side frames.

The Impression Cylinder.—The impression cylinder is also ground perfectly true, and is mounted on a strong steel shaft. There is bolted to each end a wheel in mesh with the corresponding wheel on the plate cylinder, thus causing the two cylinders to revolve together. Unlike the plate cylinder, the impression cylinder is journalled not in fixed but in eccentric bushes, to ensure that it will move out of contact with the plate cylinder when the inking plate comes round to it. This is effected by the following *trip mechanism*.

On each eccentric bush there is a tail-piece, to which is attached, by means of adjustable couplings, a toggle lever mounted on a trip shaft which extends the whole width of the machine. On this shaft and keyed to it there is a radial piece having two lugs or notches on its periphery. Swivelling loosely on the boss of this radial piece there is another lever carrying two pawls which point in opposite directions and engage with the lugs on the fast lever. The lever carrying the pawls oscillates continuously, and is operated by a cam attached to the end of the impression cylinder. It is obvious that if both pawls engage with the lugs at the same time the cylinder will move in and out all the time, but as this is not desired a further radial

lever is provided, having on its periphery a high and a low surface upon which ride the bowls fixed on the pawls. This lever is controlled by the pedal on the feeder's stand, so that when the pedal is depressed it moves the radial lever into such a position that the inner pawl, that is, the one next to the impression cylinder, is on the high part of the lever. The other pawl, being on the lower part, drops into position to engage with the lugs on the first radial lever, so turning the trip shaft and moving the toggle levers, and in this way drawing down the eccentric bushes and moving the impression cylinder out of contact with the plate.

The pedal may be depressed at any time. When the feeder is ready to feed another sheet, the pedal is released, thus allowing the other pawl to engage and take the cylinder into printing contact. It is essential that during printing the centres of the toggle levers and the coupling rods should be in a dead straight line, so forming a lock which will resist the heaviest impression. The rods are composed of right- and left-hand screws with couplings and lock nuts to suit By means of these couplings the rods may be shortened or lengthened to regulate the degree of impression. The cylinder coverings are tightened in the usual way by means of a ratchet bar.

Steel finger grippers mounted on a steel shaft are used, and are operated by means of a tumbler at the end of the shaft coming into alternate engagement with two pins, one for opening and the other for closing the grippers.

The Inking Mechanism.—The speed of a rotary machine necessitates exceptional inking power. The ink-box is fitted with a flexible steel blade regulated by means of fine-thread thumbscrews set close together, which allow the flow of ink to be regulated to a nicety at any point. The *ink-cylinder* in contact with the blade is operated by a pawl and ratchet arrangement capable of wide adjustment, just as in the flat-bed machine already described. The *ductor roller* conveys the ink by vibrating from the ink-cylinder to a large, geared revolving drum which oscillates in the direction of its length. This *oscillating ink drum* is surmounted by a pyramid of *distributing rollers*. The ink is taken from the drum by an intermediate roller on which is a polished steel rider, and is transmitted thence to one of the riders on the *forme rollers*, and so to the forme rollers themselves, whose number varies according to the size of the machine. Each pair of inkers is in contact with a geared oscillating steel rider, and the separate pairs are coupled together by means of polished steel riders, so that the ink will pass over all the rollers, besides being distributed on the inking plate or slab of the plate cylinder. The setting and the adjustment of the rollers

are practically the same as in the geared inking arrangement on flat-bed machines, with the exception that the fork blocks are on a slide at a radius from the centre of the cylinder, so that a roller when once set to the plate may be moved into closer contact with the rider without altering its position relative to the plate.

There is a *roller lifter* which is automatic, instead of being operated manually like the flat-bed lifter, and which permits of the machine being run with the inking rollers in any one of the three following positions: (1) Lifted clear of both printing and inking plates: (2) lifted clear of the printing plate, but in contact with the inking plate: (3) in contact with both plates. The roller lifter is coupled to the cylinder trip, so that when the cylinder is tripped the rollers automatically take up the position described above as (2). At the same time the rollers can be controlled by means of a hand lever, fitted with a spring pin, which engages with any of three notches, representing the three positions above noted. They are then independent of the cylinder trip. The mechanism for lifting the rollers is very similar to that of the cylinder trip.

The roller-lifting mechanism also checks the ink supply, as it puts into operation a flat bar which moves a lever into contact with a tail-piece on the duct lever, holding it stationary. This is easily disconnected to allow of the ink supply being continued when the rollers are lifted. When the cylinder trip, roller lifter, and ink check are working automatically, and the cylinder is tripped, it follows that for however many revolutions it remains tripped, neither the plate nor the rollers receive any more ink, and after throwing the cylinder in again the next sheet printed will be exactly like the previous one.

The Damping Mechanism.—A most important feature in plate printing is the damping, and a damper with a wide range of adjustment is a necessity. The water is contained in a brass trough, in which there is a slowly revolving brass roller, by which the water is picked up. It is thence conveyed through the ductor roller to a geared oscillating intermediate brass roller in contact with the two damping rollers. The amount of water is regulated by the period of contact of the ductor roller with the trough roller, known as the *dwell* of the former. The ductor roller is controlled by means of a bowl riding on a sleeve cam mounted on the side shaft. While the machine is running, this cam can be moved along the shaft through the agency of the convenient handle, so regulating the dwell of the duct roller from the maximum to nothing. The forme-damping rollers are in contact with the geared intermediate roller and are continuously driven by it, their setting being similar to that of the inking rollers. The whole of the damping apparatus may be swung

away from the cylinder to allow of easy access to the rollers, and there is an arrangement whereby the forme-damping rollers can be held out of contact with the plate through the depression of a pedal on the feeder's stand.

Feeding and Delivery Mechanism.—The feed-table on the rotary machine is much flatter than that on the flat-bed machine. The sheets are fed to a fixed side lay and a lifting front lay, both of which are fitted with micrometer adjustments. The off side of the impression cylinder, that is, the part not covered by the blanket, is fitted with grooves corresponding in width to the front lays. The gaps are spanned by bridges, one opposite to each groove, so that the lays ride on the bridges and in the grooves, thus allowing the sheet to be laid to the face of the cylinder, and in this way avoiding the creases and register difficulties caused by the sheet being bent over the under lays. The rising and falling of the front lays are operated by means of a bowl riding on a cam on the impression cylinder shaft, which should be set so as to lift the lays immediately after the grippers have nipped the sheet.

A *brush* is fitted to the impression cylinder, built in sections, so as to smooth out the sheet and cause it to lie flat to the cylinder. The brush is automatic in action, and is easily adjusted to the different sizes of sheets. On the front lay shaft there are *smoothers* for the purpose of taking away any cockle or unevenness from the gripper edge. On a separate shaft, and controlled in a similar manner to the front lays, are the *drops*, which are weighted fingers for dropping on to the sheet and holding it steady while the gripper closes and the lay lifts. The delivery of the sheets on a rotary machine is very similar to that on a flat-bed machine.

The Slow Turning Motion.—The slow turning motion is a very useful adjunct to the rotary motion. It is operated in the following manner. Attached to the loose pulley there is a sprocket wheel round which there is a roller chain. On the base of the driving stand there is a bracket which carries a short shaft, upon which there swivels a lever carrying a pulley grooved to suit the periphery of the flywheel. The chain on the sprocket wheel on the loose pulley drives another sprocket wheel which runs loosely on the short shaft, and has attached to it a pinion which in turn drives a pinion connected with the grooved pulley. It is obvious that while the belt is on the loose pulley, the grooved pulley will always be revolving, but in its normal position out of contact with the flywheel. The contact is brought about, when desired, by depressing a pedal which causes the lever to swivel upwards until the grooved pulley engages with the rim of the flywheel, which then revolves. The

pedal is placed near the water trough, convenient to the operator when putting on or touching up a plate. The gearing in this motion is so arranged that the cylinder revolves very slowly. In this way it is always under full control, and can be instantly stopped in any required position by the operator releasing the pressure on the pedal.

The Flat-bed Offset Machine.

Introductory.—The offset arrangement is really an addition to the flat-bed direct printing machine, and a flat-bed offset machine can be changed in a few minutes so as to work as a direct machine. (See Fig. 64.)

The Transfer or Offset Cylinder.—The main structure of a flat-bed offset machine is exactly the same as that of the direct flat-bed machine already described in chapter XVII, but the impression cylinder must be covered with a *rubber offset blanket* in order to transform it into the transfer or offset cylinder. When the blanket is new, it is advisable to let the cylinder and the stone run in contact for a short time to roll out the blanket, and any slackness can then be taken up by means of the ratchet bar at the tail edge.

The Impression Cylinder.—This cylinder is of half the diameter of the transfer cylinder, and is journalled in cast iron blocks, carried in two very strong brackets attached to the main side frames. It is ground micrometrically correct and has no covering. The cylinder blocks are held in position by screws at top and bottom, the top screws bedding on to steel plates, between which and the cylinder blocks there are hard rubber pads, which give all the elasticity required.

The setting of the impression cylinder is a very simple matter. It is only necessary to turn the machine until the blanket and the impression surface are opposite each other. Then on slackening the bottom screws the impression cylinder drops on to the transfer cylinder, the necessary pressure being obtained by means of the top screws. When the right pressure is obtained, the bottom screws should be tightened up to lock the cylinder in position.

Feeding and Delivery Mechanism.—The sheet is fed in the usual manner to the gripper on the transfer cylinder, which carries it forward to the impression cylinder. The gripper of the transfer cylinder retains its hold of the sheet until its edge has gone beyond the point of contact of the two cylinders, when it opens and allows the sheet to be taken by the grippers of the impression cylinder. It will be noted that the transfer from gripper to gripper does not take place until the sheet is actually

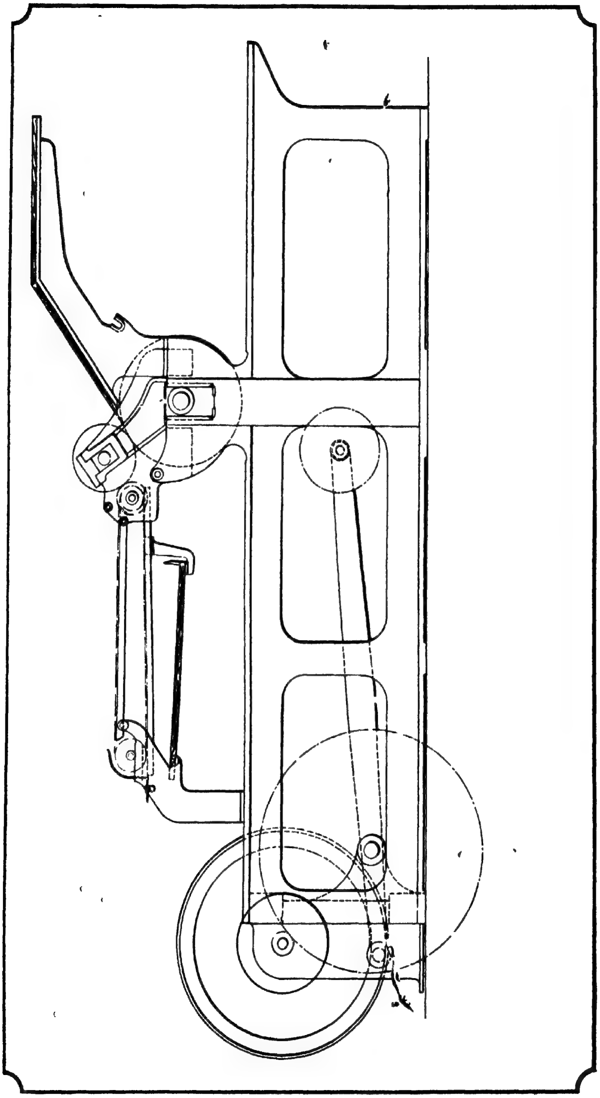


Fig. 64.—Flat-bed Offset Machine : Feeder's Side Elevation.

nipped by the cylinders, thus ensuring perfect register. Another feature of this arrangement is that the sheet is fed exactly as in the direct machine, to the same lay, gripper, etc., so doing away with any need for lifting or moving the feed-table in any way. After the sheet is taken by the impression cylinder it is conveyed forward until it is transferred to the delivery grippers, which are mounted on cross shafts carried by endless chains. The sheet is then carried forward and deposited, printed side up, on the delivery-board, which is placed adjacent to the ink-box.

Prevention of Doubling.—It is of the utmost importance that the stones or plates should be perfectly level, for if they are otherwise the contact between stone and blanket will not be maintained, and doubling, that is, the printing of lines double, will result.

Conversion to Direct Machine.—To convert the machine to a direct one it is advisable, though not absolutely necessary, to raise the impression cylinder until there is clearance between the blanket and the polished surface. The gripper of the impression cylinder is made to remain closed by throwing over a small handle on the cylinder bracket, which takes the cam out of the path of the gripper bowl. The cam piece on the cylinder blocks, which controls the gripper on the transfer cylinder, has a different position for direct printing, and it is only necessary to remove the screws, put the cam in its second position, and then nip up the screws. The gripper then closes on the sheet and retains its hold until after passing the stone to be taken off either by hand or by the flyer drum.

The Rotary Offset Machine.

General.—The rotary offset machine (Figs. 65 and 66) is in many respects so like the direct rotary machine that it is only necessary to call attention to its special features. Its general arrangement may be understood by picturing in one's mind a direct rotary machine with a third cylinder directly over the plate cylinder. The cylinders are much smaller in diameter in order to obtain the very great speeds required in offset printing. The top cylinder, which carries the printing plate, is surmounted by an inking arrangement that is almost identical with that of the direct rotary machine, except that both the forme and the distributing rollers, in addition to the automatic lifting arrangement, are fitted with hand levers by means of which they may be lifted or dropped at any time.

Since the direction of rotation of the plate cylinder is reversed owing to the introduction of the intermediate or

transfer cylinder, the damping apparatus is placed at the opposite side of the cylinder. The damping mechanism is similar to that of the direct rotary machine.

The Transfer or Offset Cylinder.—The transfer cylinder is journalled in the side frames in eccentric bushes, and has stretched over its surface a level rubber blanket free from pinholes. A new blanket should be well rolled out in contact with the plate, and the slack should then be taken up by means of the ratchet rod at the back edge of the cylinder. Under this blanket there is another exactly the same, which has its front edge fixed to the bar but its back edge loose. It has been found by experience that the combination of these two blankets gives the best results; and as they are interchangeable the bottom one may be placed on top when the surface of the top one is no longer perfect. Care should be exercised in putting on the blanket, as there is a considerable difference in the amount of stretch. Some makers mark which should be the gripper or back edge, so avoiding any chance of putting it on the wrong way.

The pressure between the transfer and plate cylinders is regulated by means of a right- and left-hand thread coupling on the rods attached to the eccentric bushes of the transfer cylinder. A quick and easy method of setting the cylinder is as follows. Place the transfer cylinder in contact with the plate cylinder, blanket to plate, by means of the hand lever described below. Drop the eccentrics by turning the coupling nuts, until the plate and blanket do not touch; then place a strip of paper between the cylinders at each side and put on the pressure until the strip at each side can just be pulled out from the nip of the cylinders. The transfer cylinder is then level with the plate cylinder, and the required amount of pressure may then be obtained through the coupling nuts, care being taken to give each coupling the same number of turns to ensure that the cylinders remain parallel. Above all, it is most essential that the height of the plate and of the blanket, in proportion to the cylinder bearings, should always be exactly as stated by the makers of the press. So long as the blanket is even and in good condition, the amount of pressure required between the plate and the blanket is not very great, but it is well to adhere as closely as possible to the maker's figures.

Besides the automatic trip, the transfer cylinder is fitted with a hand lever whereby it is possible to throw the cylinder into and out of contact at will. This will be found useful when starting a job, for first getting the impression right on the rubber before regulating the impression or paper-carrying cylinder.

The Impression Cylinder.—The impression cylinder is also

journalled in the side frames in eccentric bushes, and is fitted with a trip mechanism identical with that of the direct rotary machine, but coupled to it is the trip of the blanket cylinder, so that when the pedal on the feeder's stand is depressed, the contact of the three cylinders is broken. The pedal, like that of the direct machine, can be depressed and notched under the feeder's stand, the cylinders remaining tripped until it is released and allowed to rise. There is no blanket or other covering on the impression cylinder, the sheet being fed to a surface ground perfectly true, thus giving a sharp, crisp impression. The adjustment for different thicknesses of sheets, boards, etc., and the regulation of pressure are obtained by means of the coupling nuts as in the case of the blanket cylinder, the same method being adopted.

The Feeding Mechanism.—The laying of the sheets and the gripper mechanism are almost identical with those of the direct rotary machine, the cylinder being likewise fitted with grooves and bridges. The lay motion lends itself nicely to the use of an automatic feeder.

The Delivery Mechanism.—The delivery of the sheets is effected by endless silent chains carrying grippers which receive the sheets from the impression cylinder and take them forward to the delivery-table, which is fitted with a sheet-adjuster, and is placed just below the transfer cylinder. It will be obvious that the operator can stand at the back of the press and have in full view the ink-box, the printing plate, the blanket, and the finished sheet, all at the same time. A sheet-counter is fitted, so arranged that when the cylinders are checked it ceases to record.

Device for Ensuring Register.—The cylinders are geared similarly to those of the direct rotary machine, but each gear has in addition a register segment, that on the transfer cylinder being part of the cylinder wheel, while the other two are separate and adjustable. The object of these segments is to take up the back lash in the cylinder wheels, so that the cylinders will pitch on the same place every time, thereby ensuring correct register.

Gear Marks.—Gear marks are common on certain of the older makes of lithographic machines, and they have not been entirely overcome on the new; the sensitive rubber of the offset machine being especially susceptible to them. These marks are sometimes called *ribbing*, because of the rib-like streaks appearing through the work similar to those left on the ink slab after the rollers have been resting upon them. These streaks are sometimes entirely due to the faulty construction of the machine, but in the case of old machines they may be due to wear. They may, however, be caused by the peripheries of the cylinders dis-

agreeing, brought about by inattention to the correct thickness of blanketing; or the printing plate may be either too thick or too thin. Work containing large surfaces of flat tints or solids is most liable to be affected in this way.

Power for Lithographic Machines.—Unquestionably electricity is the best motive power for lithographic machines. Each machine should be fitted with an independent motor to ensure a steady drive; and this is specially necessary where offset machines are employed, because owing to the resilient, sensitive nature of the rubber it is next to impossible to prevent fine hair-lines from doubling when the smooth running of the machine is being constantly interfered with by other machines and transferring presses momentarily checking the power as they restart or stop when they are driven from a general shaft.

AUTOMATIC ACCESSORIES OF LITHOGRAPHIC MACHINES.

Automatic Feeders.—The time is not far distant when nearly all up-to-date lithographic machines will have an automatic feed attachment. There are several forms of these self-feeders at present on the market which give very satisfactory results.

The Harris Feeder (see in Fig. 88 on p. 210).—The Harris feeder forms an integral part of the machine. It is of very simple construction and feeds up to 5000 sheets per hour, but it is better to have a young person in attendance to place the bundles of sheets in position as the feeder takes them away, which, however, in no way interferes with the continuity of the run. A bundle of sheets is "fanned out" slightly in a manner so that the top sheet is a little in front of the others and so on, and the whole slipped down the sloping board. The sheets then lie in this position upon a rubber-covered rest. A revolving rubber-covered roller catches the sheets one at a time and places them on to a series of revolving rollers which carry them in quick succession to a stop just before the gripper snatches them after they have been pushed into exact position by a side lay. Before this bundle is finished the young person slips another bundle gently down below the bottom sheet of the first bundle; so there is no stopping to wait for paper. It is fitted with an automatic trip or throw-off device which immediately places the press out of action after the last sheet has passed through. This also comes into action should by any chance more than one sheet be fed up to the printing cylinder. First-class colour work may be printed at the rate of 3500 to 4000 sheets per hour.

The "Slogger" Feeder.—The "Slogger" is a feeder of the "pile" type, which after loading is ready for a long, continuous run. The top sheets of the pile are kept in a loose condition by a blower. The space occupied by this feeder is the depth of the largest sheet capable of being worked by press plus 17 in. After carefully stacking the paper on the loading board the apparatus is ready to start. The sheets are held at the front corners by feelers, and a pressure of wind is directed into the front feed edge of the paper by a vibrating trough or nozzle, loosening some forty or fifty sheets in the pile, and finally, in its upward movement, carrying the top sheet clear of the others,

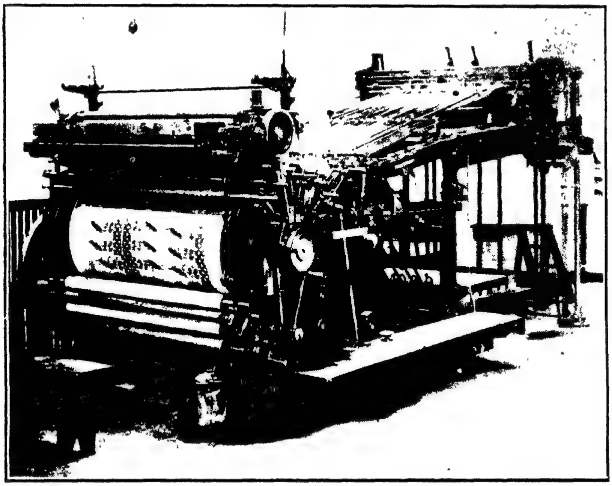


FIG. 67.—"Slogger" Automatic Feeder attached to L. & M. Rotary Litho Machine.

rendering such sheet ready for delivery, and in perfect control, to the printing machine. The feelers now rise, and a pair of spring strokers come into action simultaneously with the rising of the feelers, carrying the free top sheet forward on to moving tapes which carry the sheet down to within 1¼ in. of the front lay. The sheet is then caught and steadied by spring catchers, which open and let the sheet travel gently up to the front lays. A most efficient side lay (easily adjusted by a screw for the different weights of paper) now comes into operation; this effected, the spring holders now grip the paper and hold it in position

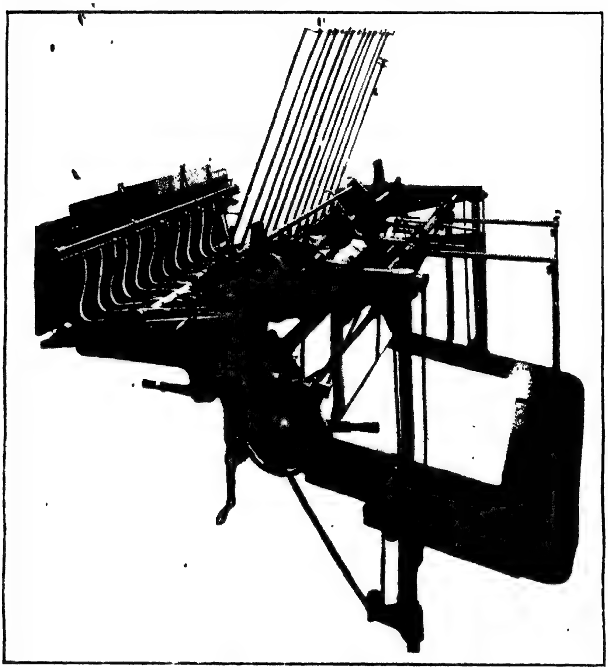


Fig. 68.—The "Slogger" Automatic Feeder: Showing Front Portion of Layboard raised to enable Operator to get at Cylinder.

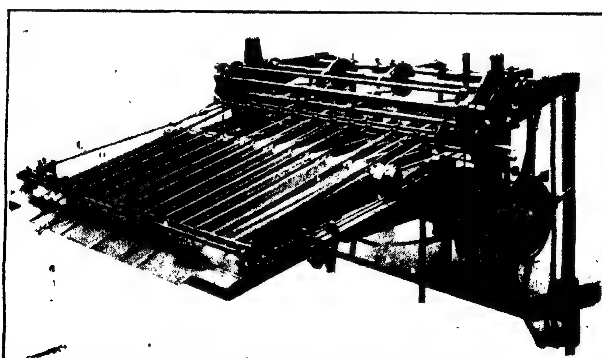


Fig. 69.—The "Slogger" Automatic Feeder Ready for Working.

until the cylinder is ready to take it away, so that the sheet from the time of leaving the pile is under positive control. (See Figs. 67-69.)

The air separation is very powerful and does varied duties, and will separate any weight of paper from tissue to antique. It constantly loosens the pile of paper, finally separating the top sheet; continually passing between the sheets, it has the effect of drying them, and if they are already printed on one side, with one or more colours, it lessens the chance of offset. With the rough and antique types of paper, the constant passage of air through rids the paper of dust and fluff, and so keeps the formes clean, thus giving a longer life to both ink and rollers. It avoids continual washing up and loss of time, and is in actual operation on each individual sheet. It is fitted with a self-acting arrangement for tripping the press cylinder and stopping the press in case the sheet is not correctly carried to the front or side lay, or if half sheets or turned corners are fed from the pile. It will feed any material that can be printed on a

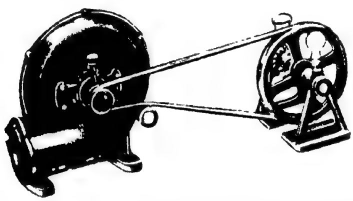


FIG. 70.—The "Slogger" Automatic Feeder: Improved Blower.

letterpress or rotary litho machine of any description. There is nothing in the feeder to damage the paper, whatever its texture or surface may be; and it will feed the thinnest catalogue paper or a three-ply board with equal facility.

The "Dexter" Feeder.—The "Dexter" feeder (Fig. 71) is also a pile feeder of a very high grade. It will feed all classes of colour and label work to mechanically accurate register. It is equipped with all the latest devices for automatic control of the press; for detecting the feeding of more than one sheet at a time; and for their perfect control while being fed. Devices which are positive in action are employed to carry and place the sheet, and at every step in the process the accuracy of these devices is certified, as it were, by others that are independent and permit of no variation from the rigid standard required. The adjustment for register is simple and easily made and unerringly maintained, the checking or certifying devices being seldom called into play.

A distinctive feature of the "Dexter" feeder is an arrangement of the driving power so that the feeding machine may be operated independently of the press. Each feeder is equipped with a ¾ h.p. motor (or with shaft for belt where motor drive is not used) placed on top of the machine. This motor serves principally to run the piling board up and down, which, by having independent power, can be done while the press is standing still. This is convenient and saves time, as the pressman is not interfered with while the attendant is refilling

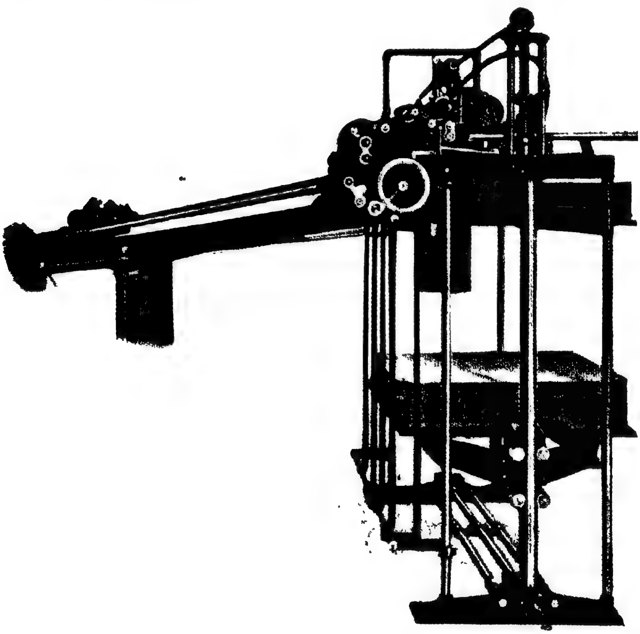


FIG. 71.—The "Dexter" Automatic Feeder.

the feeding machine. This extra power is also used to drive the blower, and to operate the feeder independently of the press.

All types of feeders will, of course, occasionally feed more than one sheet off the pile, and will also send forward sheets with turned corners. It is therefore necessary to have a positive mechanical calliper as a safeguard against damaging the forme. In this machine there are two mechanical callipers, one on each side of the machine, just in front of the pile. The callipers are

set to one thickness of paper: the sheets are advanced through the callipers, which are actuated by the sheet if more than one is present or if the corner is turned on either edge.

The automatic action of the calliper serves directly to arrest the operation of the feeding machine proper, the stopping of the press being incidental to the stopping of the feeding machine. If the press is in the act of taking a sheet when the feeder is stopped the impression will be completed, and the press will be automatically tripped and stopped just before the grippers close on the next succeeding sheet. With this arrangement the impression cylinder cannot possibly rest on the forme, and a white sheet cannot be delivered on the fly-table (or delivery-table) of the press.

In their new rotating buckler finger the makers have developed an entirely new principle in buckling devices for feeding machines. This consists in causing the rubber buckler finger to rotate slightly while at the same time it moves forward, with the advantage of rolling the corner into an arch or buckle in precisely the same way as is done with the finger in hand feeding. By this means the corners are buckled or arched with very little, if any, tension on the finger, thereby avoiding the liability of buckling more than one sheet at a time.

The buckling of the corners is the beginning of the operation of feeding: therefore it is essential to start right, as upon this the success of the machine largely depends.

For convenience in stopping press and feeder there is provided a stop lever at either end of the ink fountain, just under the fly-board of the press. By this handy arrangement the pressman has control of the press from this position, and can stop the machine without running to the regular belt-shifter. In this way he simply brings into action the automatic stopping device, which applies the brake and trips the impression with more precision than can be attained in the usual way.

Fly trips have nothing to do with actual feeding, but they serve to make more perfect the control of the press. Simple mechanical fingers rest immediately above the sheet as it leaves the cylinder. If the press fails to run the printed sheet out on the fly or delivery in a proper manner, it usually chokes up, and this causes the fingers to trip and stop the press, thus preventing the "bunched" sheet from damaging the form.

It will be seen that with this attachment the makers have gone a step further than simply feeding sheets to the guides. They have succeeded in arranging both press and feeder by means of simple mechanical devices to be automatically controlled by the travelling sheet from the time it leaves the pile on the feeding machine until it reaches the delivery-board of the press.

The Jogger.—The jogger, or automatic sheet-adjuster (Fig. 72),

is a mechanical contrivance for the purpose of evening up the sheets as they are delivered by the flyers on to the delivery-table.

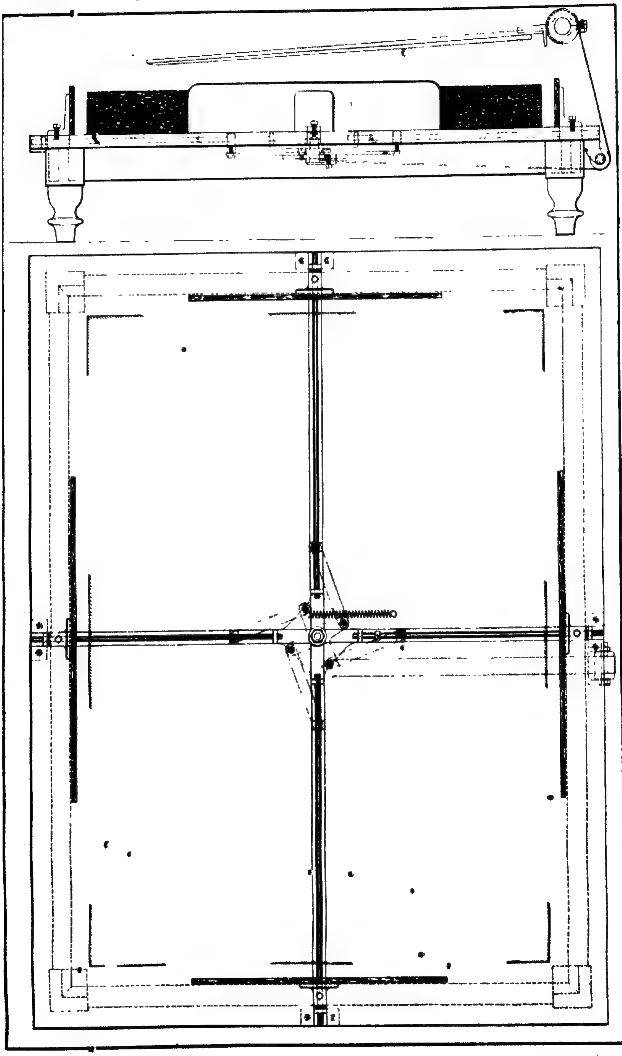


FIG. 72.—Jogger or Automatic Sheet-adjuster.

It consists of four oblong sides of about 4 in. deep which form a kind of sectional framework. These sides, or sections, may

be altered to suit any size of sheet by loosening a simple thumbscrew on each and then sliding them along the rods to which they are fixed. The rods are arranged in a cross slit in the delivery-table, and are indirectly attached to a small iron crosspiece underneath. One section of this crosspiece is longer than the others, and on to this an end of a leather strap is attached. The other end of the strap is fastened to the rod that carries the flyer sticks. When the flyer is in action, it draws the strap, which, in turn, pulls the long section of the crosspiece, causing all four sides of the jogger to expand simultaneously. The strap is then loosened by the reversing action of the flyer after it has delivered the sheet, when a spiral spring which is working in opposition to the strap comes into operation and pulls the opposite section of the crosspiece back again, thus closing the jogger and leaving the sheet in its exact position on top of the others.

The Automatic Counter.—An automatic counter for registering the number of sheets printed may be attached to any lithographic printing machine, whether of the flat-bed or rotary type. It is a kind of clockwork arrangement similar in appearance to that which may be seen on a gas meter for registering the quantity of gas consumed. It may be worked in connection with the journal of the impression cylinder, or the flyer rod, or almost any other part of the machine having a regular movement as each print is taken. It is sometimes necessary to disconnect it when "making ready" or running waste sheets; otherwise the total number recorded at the end of the run will be misleading.

CHAPTER XX.

EXAMPLES OF PRINTING MACHINES.

Introductory.—Having described the general structure and working of the various types of lithographic machines, we shall now put before the reader a selection of actual machines by various makers, British and American, showing the variety of form and detail assumed by each type in practice. Each machine is illustrated and described sufficiently, with special reference to its characteristic features. At the end of the chapter we give examples of two- and three-colour machines, types to which no reference has hitherto been made.

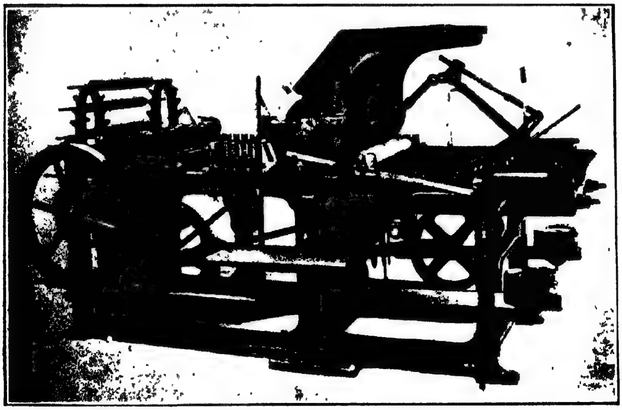


Fig. 73.—An Early Type of Furnival Flat-bed Machine, 1865.

The "Wogdon" Improved Litho Press.—The "Wogdon" machine is a combined litho press and printing machine of simple construction. It can be used for proving, and for this work its self-inking and self-damping equipment render it emi-

nently suitable. It transfers to stone or metal; it yields sharp and clear reverse transfers very rapidly; and it proofs offset work. It is a rigid flat-bed machine, and there is no locking up and no "make ready" necessary. The stone (or metal plate) is as accessible as that on a hand press, and any branch of work that can be done on a hand press can also be done on a "Wogdon". Its printing capacity is from 800 to 1000 per hour, and short runs are profitable on it. The makers claim that it enlarges the field open to litho work, rendering lithography commercially possible for work that hitherto it could not touch. (See Fig. 74.)

By changing the inkers and the blanket the press may readily be converted into a letterpress proofing and printing machine.

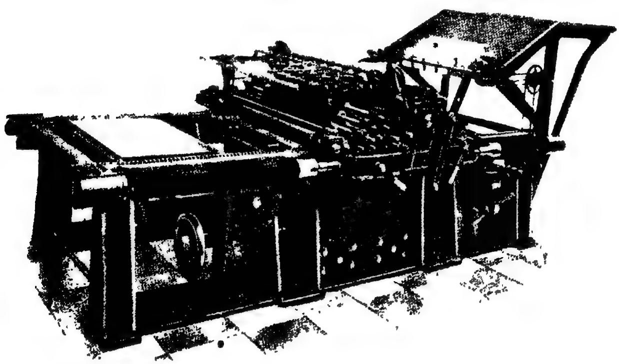


FIG. 74.—The "Wogdon" Press.

Furnival and Co.'s Improved "Express" Direct Flat-bed Machine.—This machine, manufactured by Furnival and Co., Ltd., has very massive framing, built up with strong stays and longitudinal bearer rails securely bolted and braced together. The cylinder is ground absolutely true on the surface; the pressure is applied by the method of weights and levers characteristic of this firm's machines, and a massive box girder is fixed directly under the cylinder to sustain the pressure without yielding, thus ensuring a sharp "nip" and the necessary elasticity required for producing the highest class of printing. Double driving gear is fitted. The cylinder wheels and racks, and the wheel and rack for propelling the carriage, are all

machine-cut out of the solid, ensuring quiet and steady running. An automatic double registering apparatus is fitted, giving perfect register, and when required allows of two sheets being fed into the machine at once. (See Fig. 75.)

The improved inking arrangements are such that double inking is rendered unnecessary for almost every class of work, although the double-inking arrangement is fitted to each machine in case it may be required for some very special purpose. A new improvement has been introduced in the inking roller brackets, in which bushes are fitted to the roller spindles and fixed in the brackets, thus ensuring that the rollers will run with greater steadiness and quietness, while not interfering with the diagonal rolling. This arrangement prevents the rollers from jumping when coming in contact with the edge of the stone, and reduces the danger of skidding to a minimum.

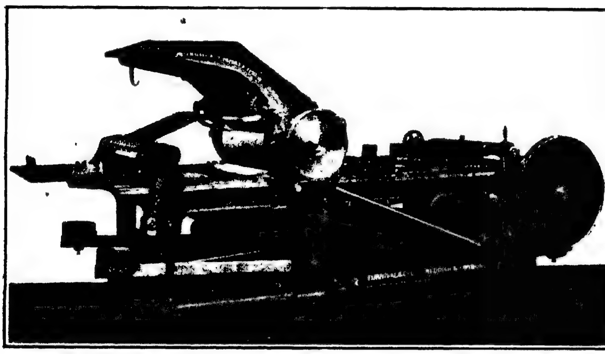


FIG. 75.—Furnival's "Express" Direct Flat-bed Machine.

There is an extra distributing arrangement, which is fixed near the ink duct, and is arranged so that the ordinary duct roller, instead of depositing the ink direct on to the slab, deposits it on a leather-covered roller with a polished steel rider in contact, and then the ink is transferred to the slab by the leather-covered roller, thus getting a perfect distribution of ink on the slab. Geared reciprocating riders can also be fitted to the inkers and dampers.

An improved lath and cord flyer can be fitted when required. This is arranged so that each flyer lath can be moved to any position required. A jogger or automatic sheet-adjuster can be supplied to machines fitted with flyers, which is exceedingly simple, and "knocks up" the sheets perfectly (see p. 186).

The Scott Stop-cylinder Flat-bed Machine.—This American machine (Fig. 76), manufactured by the Scott Company, is designed to meet the demand for a stop-cylinder press of large size to run at great speed. It is primarily constructed to print from stone, but by using a suitable bed it can print from metal plates. The stone is fully exposed when under the feed-board; it can be put into the box from behind, or let down through the feed-board. It passes under five inking rollers and two damping rollers twice. The bed is driven by a special hypocycloidal motion, and is supported by steel rolls placed between steel tracks of extra width. Air-cushioning cylinders assist in reversing the bed.

The impression cylinder is of small diameter, giving a sharp impression. It is started and stopped by large cams, is geared

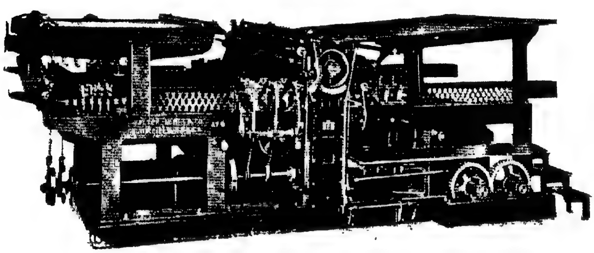


FIG. 76.—The Scott Stop cylinder Flat-bed Machine.

to the bed at both ends while in motion, and can be tripped by the feeder.

By pulling a lever the inking rollers are separated from each other and raised from the stone. By means of another lever the damp rollers are raised from the stone; they can be removed and replaced without deranging their adjustment. The ink fountain is constructed for fine adjustment. The knife can be removed for cleaning and replaced in exactly the same adjustment. When cleaning the ink table and angle rollers, the delivery-board is slid towards the impression cylinder. The damping devices are much improved. The fountain and distributing rollers are brass-covered to prevent rust.

The sheets are delivered in front with the printed side up, in view of the machineman who regulates the colour. When double-rolling, a slip sheet can be passed through the machine at each second stroke of the bed, while the impression is tripped.

The largest size of the machine has an extreme length of about 18 ft. and an extreme breadth of fully 12 ft., the height being nearly 6 ft. This size weighs fully 20 tons, and takes stones up to 45 in. × 70 in. The working speed may reach 1500 per hour, for a rather smaller size.

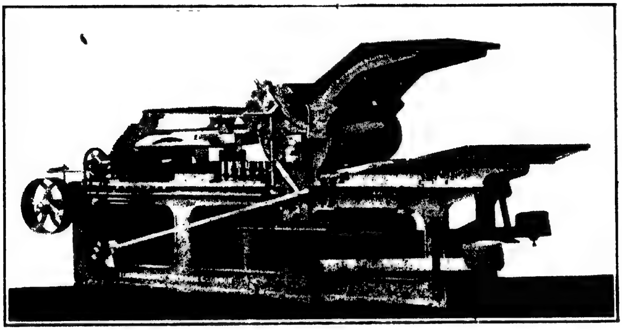


FIG. 77.—Furnival Offset Attachment for Flat-bed Machines.

Furnival & Co.'s Flat-bed Offset Machine Attachment.—This is an arrangement that can be fitted to any flat-bed machine, and will enable the owners to cope with any offset work that may come along. To print offset with this arrangement,

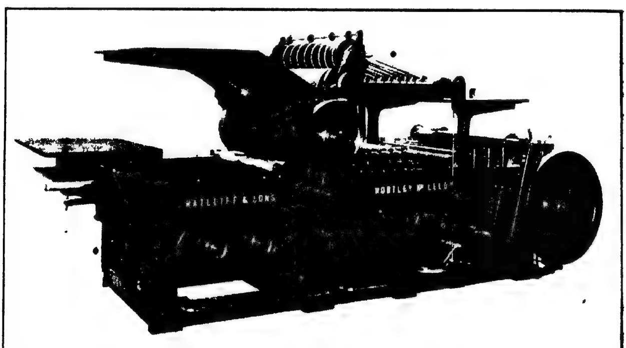


FIG. 78.—The "Reliable" Flat-bed Offset Machine.

the rubber transfer blanket is put on what is now the impression cylinder. The sheet is fed into the present gripper and then

transferred to the gripper in the top cylinder. After printing, it is conveyed to the lath and tape flyer and deposited printed side up on the delivery table. The machine can still be used for direct printing, the change being made from one to the other in two or three minutes. The makers, of course, supply new machines complete with this offset arrangement. (See Fig. 77.)

The "Reliable" Flat-bed Offset Machine.—This machine, manufactured by John Ratcliff & Sons, has been designed for producing the highest class of commercial and colour work on any class of paper, either hard hand-made or the roughest grained, and will give perfect impressions with accurate register.

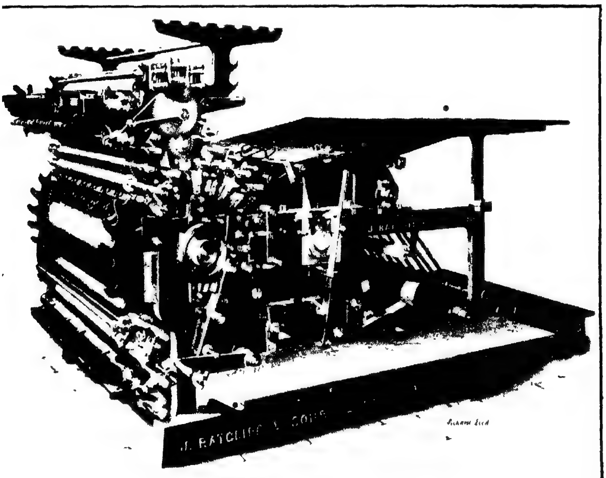


FIG. 79.—The "Reliable" Direct Rotary Machine.

It is equally suitable for either long or short runs, and can be used for printing from either metal plates or stone. It is simple in construction. (See Fig. 78.)

The "Reliable" Direct Rotary Machine.—This machine (Fig. 79), by the same makers as the previous one, stands on an exceedingly solid and heavy bedplate, and has solid frames which are of uniform thickness throughout, instead of being ribbed like those of some makers, thereby doing away with all vibration, and ensuring a heavy and solid impression.

The cylinders are made in the strongest possible manner, having massive steel shafts, giving great rigidity, which is so es-

sential for obtaining a good impression. They are turned on their own necks, which ensures their being true. The bearings which carry the cylinders are bushed with gun metal and bored out in their working position in the machine. The plate clamps open automatically to receive the plates, enabling the operator to have both hands at liberty when changing the plates. It will also be found that the plate is very easy of access on this machine, and a large space is left between the damping and the inking rollers for washing or cleaning the plate.

Every inking roller on this machine has an independent adjustment, which can be set while the machine is running. The rollers are checked automatically each time the machine is tripped, and are lifted off the plate when the machine is stopped. There is also a means for lifting or lowering the rollers by hand, when required, in any position of the cylinders. The distributing and the inking rollers are of the same size and interchangeable. The ink feed is also checked, if required, each time the machine is tripped. The distributing rollers are also capable of being lifted clear of the drum when necessary. The ends of all rollers project beyond the sockets far enough to enable the operator to handle them easily, when lifting in or out. A special feature of this machine is that, after tripping, the inking rollers are brought down to ink up the plate before the next sheet is printed, thereby avoiding any waste of sheets through an imperfect supply of ink.

The inking rollers have a side adjustment, with a set screw to hold them in the desired position. Further, they are set to the plate with a screw adjustment, and are arranged so that they can be set to the riding roller without altering the plate adjustment. When they are tripped they move to either side of the riding roller, thereby doing away with the need for moving the riding roller out of gear.

The damping apparatus is simple and easily adjusted, having a micrometer or screw adjustment to the cam lever, which actuates the feed roller, allowing the flow of water to be adjusted while the machine is running. The water motion has two speeds, giving any variation of supply that may be necessary under any conditions. The roller brackets can be dropped from the plate cylinder low enough to take out the rollers with the cylinder in any position. The rollers are automatically checked, if required, but if this is not desired, each time the machine is tripped it can be made to damp in the regular manner by throwing out a small lever. The damping motion can also be checked by hand when required while the machine is running, and thrown on again by a slight touch from the operator. The damper feed roller can also be checked either automatically or by hand.

The impression cylinder trip is arranged so as to enable the feeder to check the cylinder at the latest possible moment after missing a sheet, and can be put in operation at any time with safety. The inking motion and the damping motion are connected to this trip, and are checked automatically each time the machine is tripped.

The front sheet guides are easily, quickly, and accurately set by a screw adjustment, and lie in grooves in the cylinder, so that the sheet is fed directly into the cylinder itself, and the gap is fitted with ridges so that if required the sheet can be fed without the steel underlays, although the makers supply the underlays with each machine, so that individual requirements can be suited. The flyer drum is arranged so that it can be adjusted for taking off either thin paper or thick board. The sheet delivery sticks are movable, and can be thrown in or out of motion at any time or position of the machine with safety.

The machines are fitted with a slow forward motion. This motion can be thrown into action when the machine is stopped and the belt running on the loose pulley. It is arranged so that it can be actuated either from the feeder's platform or from the front of the machine. Each machine is also fitted with a motion for knocking up the printed sheets straight after delivery. A sheet-slitter is supplied with each machine.

The L. & M. Direct Printing Rotary Machine.—This machine (Fig. 80) is so called because it is manufactured by Linotype and Machinery, Limited. The plate and impression cylinders are ground perfectly true, and they are turned down in similar bearings to those upon which they run in the machine and not from a central point. The impression cylinder is provided with a safety tumbler cam for the gripper rod. This prevents any possibility of the grippers being broken, should they be left open when the machine starts. The clamps on the plate cylinder open automatically to receive the plates. They grip with perfect evenness, and being close together do not tend to bend or buckle the plate. As the upper jaws of the clamp remain open to receive the plate, it is easily and quickly inserted or withdrawn.

The backing-up motion dispenses entirely with the necessity for turning the flywheel by hand when it is required to move the machine, thus saving time and labour. This operation is effected by simply pressing a foot lever, and the machine at once backs up slowly, thus affording access to any part of the plate, as it can be stopped at any position instantly and with certainty. This mechanism can be operated by the printer when working on the plate, and also by the feeder from her platform.

The ink ductor roller is automatically held in contact with

the distributing cylinder when the press is tripped, so as to stop ink supply, and by the same mechanism the forme-inking rollers are lifted off the plate. The transfer rollers are very large, and are as accessible as all the others. The forme rollers are carried in sockets, which can be adjusted with equal facility on both sides of the machine. They are raised automatically when the press is tripped, but they can also be raised by hand when desired. The ink fountain is not only accessible to the machineman for cleaning, filling, and regulating, but it does not obstruct when putting on a plate, nor does it interfere with the sponging or with

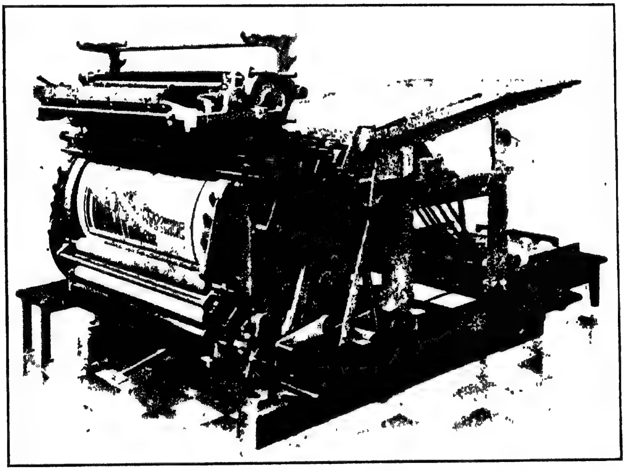


Fig. 80.—L. & M. Direct Rotary Machine.

its manipulation. The geared riders on the forme rollers revolve at all times in fixed bearings; consequently, the gearing which drives them is always in proper mesh, not necessitating the movement of a complicated spider or frame, or lifting them partly out of gear, as was the case in old-fashioned machines.

The damping mechanism is carried by two side brackets, which are lifted into position to damp the plate, and lowered about 2½ inches when it is necessary to take out the rollers, all the operative parts being easily accessible for adjustment. The evenness of the driving of the water-distributing roller, and the facility with which the dampers may be adjusted to the plate, have been carried to great perfection. The supply of water is

checked automatically when the cylinder is tripped, thus preventing an excess of water on the plate.

The delivery of the sheets has been improved by putting a safety device on the flyers, which will prevent the cam lever from being broken should the flyers be released at the wrong time. The delivery table is unusually high, which enables the machineman to examine the work conveniently, and makes it easier for him to take away the sheets.

The L. & M. Direct Rotary Machine is built in four sizes, the largest taking a plate 51 × 65 in., and the smallest 37 × 42 in. They are equipped with a rotary paper-slitter and an automatic counter.

Furnival & Co.'s Direct Printing Rotary Machine.—This machine (Fig. 81), by Furnival & Co., Ltd., is bolted to a solid bedplate. The frames are of solid plate section, which, in combination with the bedplate, ensures absolute rigidity. The driving shaft runs the full width of the machine, and is journalled in both side frames. At each end there is a pinion in gear with the wheels on the plate-carrying cylinder.

The cylinders are well ribbed, have solid arms, and are mounted on steel shafts of large diameter. The accuracy of the cylinders is obtained in the following manner. They are in the first place bored, the steel shafts then being driven in. They are then turned between centres, and finally ground by a special process, running in their own bearings. In this way the cylinders are made absolutely the same diameter, and they are submitted to a severe test before being put into the machines. In addition to the accuracy, the grinding gives that fine face to the cylinders which ensures an even impression all over the sheet.

The plate cylinder is journalled in bushes carefully let into the side frames. The printing plate is fixed by spring clamps at the front and back edges. There is a simple arrangement in the gears to allow of each plate being adjusted to register with the previous one. The impression cylinder is journalled in eccentric bushes let into the side frames. The off side of the cylinder is fitted with grooves, and the gap with bridges, in which the front lays ride. This does away with the necessity for the steel underlays, which, however thin they may be, sometimes have a tendency to cause creasing. Thus the sheet is fed direct on to the cylinder, and lies perfectly flat thereon, ensuring perfect register.

The eccentric bushes before mentioned are for the setting of the impression and tripping the cylinder. By the adjustment of these bushes, the minder brings the impression cylinder up to or away from the plate cylinder to suit the thickness of paper or

card and the amount of impression required. By the depression of a pedal on the platform, the feeder puts into motion an ingenious but simple mechanism, which gives a slight turn to the eccentrics, thus drawing the impression cylinder away from the plate cylinder, so that the two surfaces are not in contact. When the cylinders are checked the eccentrics remain stationary until the pedal is released.

The ink-box is fitted with a flexible steel blade, so that the flow of ink can be regulated to a nicety. The colour is fed from the ink cylinder to a large geared reciprocating or oscillating drum. The drum is surmounted by a pyramid of distributing

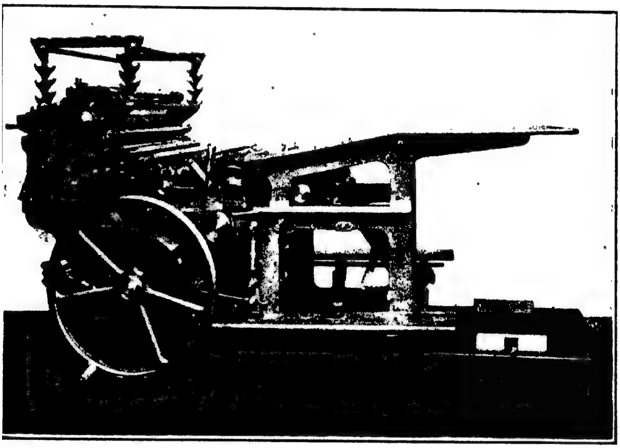


Fig. 81.—Furnival's Direct Rotary Machine.

rollers. The colour is taken from the drum by means of an intermediate roller, fitted with a polished steel rider, and is transmitted to one of the riders on the forme rollers, and thence to the forme rollers, which are eight, six, or four in number, according to the size of the machine. Each pair of forme rollers has in contact a geared oscillating polished steel rider. An intermediate polished steel rider is also placed between each pair of forme rollers, thus connecting the whole of the inking. From this it will be readily seen that the inking is very powerful, and on the other hand it will be understood that every job will not require the full complement of rollers, in which case a number can be dispensed with.

The adjustment of the rollers is very simple. The geared

oscillating riders are, of course, in fixed bearings. The blocks carrying the rollers are on a slide struck at a radius from the centre of the plate cylinder. The rollers are first of all set to the printing plate, and the blocks are then moved on the slide until the rollers are in correct contact with their respective riders. The object of having this slide on a radius is that the rollers, having once been set to the plate, can be moved in either direction along the slide without altering the relative position of roller to plate. The time saved in setting the rollers by this method will be obvious. The rollers can be run in any one of the three following positions: (1) lifted clear of both printing and distributing plates; (2) clear of printing plate, but down on distributing plate; (3) down on both plates. The roller lifter is automatic, and operated at the same time and by the same motion as the cylinder trip. When the cylinder is tripped, the rollers lift quite clear of the printing plate. Simultaneously the ink supply is stopped. Thus no sheet is double-rolled, and each successive sheet receives the same amount of colour as its predecessor.

There is a brass trough holding the water for damping, and in this trough there is a slowly revolving brass roller which picks up the water. Rubber pads are provided, which can be placed against any portion of this roller to diminish or cut off the supply. A ductor roller takes the water from the trough roller and deposits it on a geared oscillating brass roller, which is in contact with the two damping rollers. The regulation of the supply of water is obtained by means of an ingenious cam, which operates the duct roller. This cam slides on a key, and its different positions alter the dwell of the ductor roller on the trough roller, so that if much water is required the ductor roller is allowed to rest its full time on the trough roller; if less is required, then the machineman, by means of a convenient handle, moves the cam slightly, and so on into any position between the maximum and the minimum. By the depression of a pedal on the feeder's stand, the damper can be held out of contact with the plate.

The feed lays, as before mentioned, rest in the grooves in the cylinder, so that the sheet, when fed, rests directly on the cylinder itself. They can be adjusted to the finest line by means of a milled nut. The feed table is made of specially seasoned wood that will always retain its shape. It is set at the most convenient angle for feeding, and is hinged in the centre so that the front portion can be raised in order to have a clear cylinder for the purpose of putting on the blanket, etc.

The sheet is delivered in the usual way with the lath and string flyer. The fan can be held stationary by the lowering

of a small hand-lever. The taking-off drum is of cast iron, ground and polished to ensure its running accurately with the impression cylinder, thereby obviating any risk of smutting the sheet. The machine is fitted with a sheet-adjuster.

This machine is also fitted with a slow-turning motion. When it is stopped and the belt is running on the loose pulley, the cylinder can be made to revolve slowly. The machineman may be doing something at the plate, and wants the cylinder to move round a little; he presses a pedal, which is convenient to his foot, and when the cylinder has reached the desired position he releases the pressure and it instantly stops. This is of very great

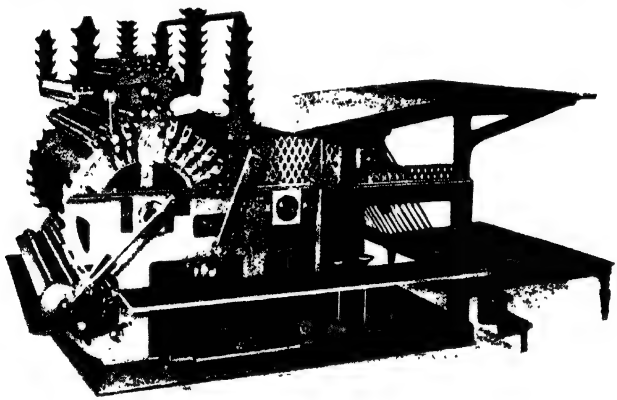


FIG. 82.—The Scott Direct Rotary Machine.

convenience when putting the plate on. A sheet-slitter can also be supplied.

The double demy size of this machine, for a sheet 36 × 24 in., covers a space of $8\frac{1}{2}$ ft. by 6 ft. 8 in. The quad double crown size, for a sheet 64 × 44 in., occupies a space of 14 ft. by $10\frac{3}{4}$ ft.

The Scott Direct Rotary Machine.—In this American machine (Fig. 82), manufactured by the Scott Company, the side frames are securely mounted on a rigid well-braced bedplate. The plate and impression cylinders are turned and ground to a true and smooth surface and carefully balanced. The plate cylinder is fitted with suitable steel clamps, which hold the plates securely in such a way as to allow of their being brought to perfect register.

The inking apparatus is located and arranged to the best advantage, the weight of the rollers giving the pressure on the inking plate and on the printing plate. The ink fountain is constructed to supply a thin film of ink, and is adjusted by thumbscrews in the usual way. The dwell of the ductor roller is indicated by a scale and is regulated by a thumbscrew. The ductor roller remains in contact with the distributing cylinder during two revolutions and one vibration of the cylinder.

The vibrating distributing ink and water rollers in contact with the forme rollers do not commence to vibrate while the printing plate passes under them. These rollers are gear-driven, and rotate the forme rollers at the same surface speed as the printing cylinders, thus preventing any undue wear of the design on the plate. There are eight forme-inking rollers. They can be raised from the printing plate when inking up.

There are three forme-damping rollers. These rollers, with their distributors, are raised and lowered automatically to damp the printing plate and clear the ink-distributing plate. They can be removed and replaced without moving their sockets. The water supply can be cut off from the ductor and the plate when inking up the distributing rollers. The water-distributing rollers are brass-covered to prevent rust. All forme and distributing rollers can be lifted from their sockets and removed from the machine without being obstructed by the frames, and can be replaced without deranging their adjustment.

The impression cylinder can be set out of contact with the plate cylinder, and can be tripped at will by the feeder. When the press is tripped, the counter does not count. The feed gauges, sheet supports, and guides are such as to facilitate the feeding and ensure perfect register. The sheets are delivered by means of a gripper cylinder and fly mounted with star wheels.

The largest size, for a sheet 45 × 65 in., has an extreme length of 14 ft. and a breadth of 11½ ft., with a height of 7 ft. Its weight is 12½ tons as boxed. A smaller size can be run up to 5000 per hour.

R. Hoe & Co.'s Direct Rotary Press.—In this machine (Fig. 83), made by the New York firm of R. Hoe & Co., the side frames, of the "box frame" pattern, rest upon a rigid and strongly braced bedplate, ensuring perfect alignment throughout. The impression and plate cylinders are of the same size. When the plate clamps are loosened, the jaws remain open to receive the plate, thus enabling the pressman to hold the plate with both hands when putting it in the clamps. Wing nuts are used to close the jaws on the plate; and, owing to the unique construction of the jaws, the plate is gripped more securely by

means of these nuts than by screws tightened with a wrench, as in ordinary clamps.

The rollers that apply the water to the plate are carried in hinged frames which can be easily swung away from the cylinder, leaving the sockets open and unobstructed; so the rollers can be put in and taken out quickly and easily. Means are provided for regulating the supply of water.

The ink is conveyed from the fountain to a large rapidly oscillating cylinder, upon which it is distributed by a set of rollers, and is then given to the group of oscillating and forme rollers

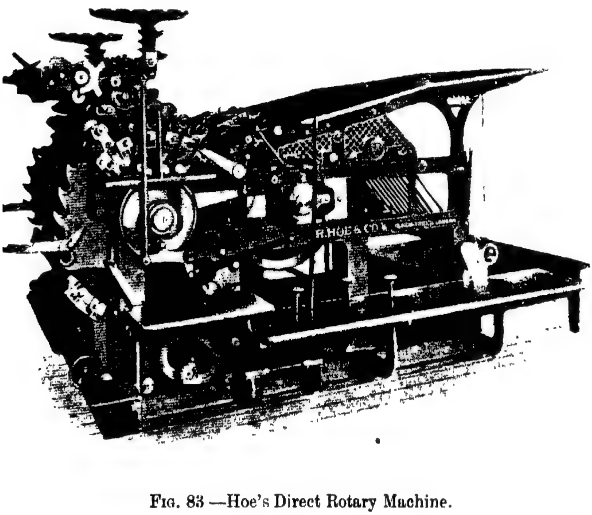


FIG. 83 —Hoe's Direct Rotary Machine.

which come first in contact with the printing plate. After further distribution, the remaining ink on the cylinder is given to the group of rollers nearest to the impression cylinder. By this method the best inking is obtained, as the thinnest and most evenly distributed film of ink is applied to the printing plate just before printing. The oscillating rollers make a complete reciprocation during the time that the inking surface of the cylinder passes under the forme rollers, but stop oscillating while the printing plate passes underneath, thus obviating the transmission of any vibratory motion to the forme rollers, which, even though very slight, has a tendency to wear the design off the plate.

When fresh ink is put in the fountain, the rollers set, and the machine run to work up the colour, the rollers are automatically

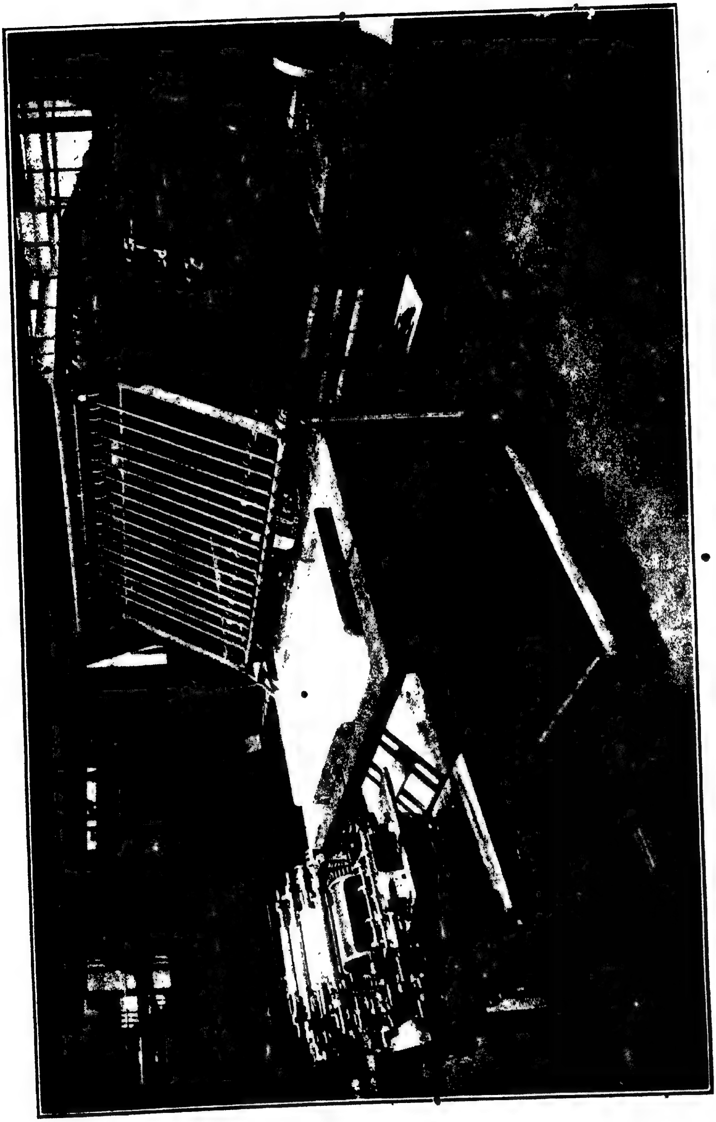


FIG. 84.—The "Baby" Rotary Offset Machine (on the left).
This illustration represents the smallest and the largest offset machines made by Messrs. Geo. Mann & Co., Ltd.,

lifted to clear the printing plate as it passes under them and brought down upon the inking surface in each revolution of the press. In this way the colour is thoroughly worked up until there is sufficient ink on the rollers and the inking surface before any is applied to the printing plate, thus obviating waste of ink and the loss of time that ensues in washing the ink off the plate when in the ordinary way the plate is inked in working up the colour. The rollers can also be kept in a raised position at will.

The press can be reversed by means of a treadle giving complete control of the machine from the feeder's stand, without having to pull on the flywheel.

The "Baby" Rotary Offset Machine.—This machine (Fig. 84), intended for commercial work, is made by George Mann and Co., Ltd. It is carried on a large cast-iron bedplate. It is fitted with an ink ductor and also a checking device which the feeder operates with her foot. This device is very simple. The feeder sits at the machine when at work, with the feet resting on a small wooden bar. If it is necessary to miss an impression, the simple action of removing the feet from this bar immediately parts the cylinders and lifts the inkers from the plate. The sheets are delivered in front of the feeder, so that they can be examined periodically without having to move from the feeding position. A large distributing drum and three large-diameter forme rollers on the plate give strength of rolling power sufficient for the very heaviest of commercial work.

The demy quarto size is about 5 ft. long by 3¼ ft. broad, and weighs only 13 cwt. gross. It can be run up to a speed of 3500 revolutions per hour, but this, of course, necessitates an automatic feeder. A motor of ½ h.p. is required to drive it. The demy folio size weighs 16 cwt. gross, and is a little larger than the demy quarto machine. It also requires a ½ h.p. motor, and can be run up to 3000 revolutions per hour.

The Waite Rotary Offset Machine.—The makers of this machine (Fig. 85), Messrs. Waite and Saville, Ltd., claim that it possesses exceptional merits. It is almost noiseless in its working. The cylinders are ground dead true while running in bearings, and all cylinders have steel shafts running in phosphor bronze bearings. Adjustments to the forme rollers are made from the outside of the machine with nothing whatever in the way, whilst none of the distributors or inkers protrude through the frame sides, so enabling them to be lifted straight out. The press has exceptional inking powers. The oscillating ink cylinders and rollers are so arranged as to break up the ink thoroughly before applying it to the plate-forme rollers, of which there are five of large diameter. The distributing rollers and mechanism, which

absorb most of the power required to drive this type of press, are driven direct from the driving shaft, not through the cylinder gears, thus causing the minimum of wear to the gears. This is a most important feature in an offset press, where the cylinder gear plays such an important part. The inking rollers can be raised from the plate while the ink is distributed without disturbing their adjustments. The ink duct has a flexible steel knife and thumbscrews, while a small lever is provided to regulate the dwell of the duct roller while the machine is running.

The damping arrangements are very efficient, and the damping rollers can be raised instantly from the plate, without disturbing their adjustment. The water supply can be quickly

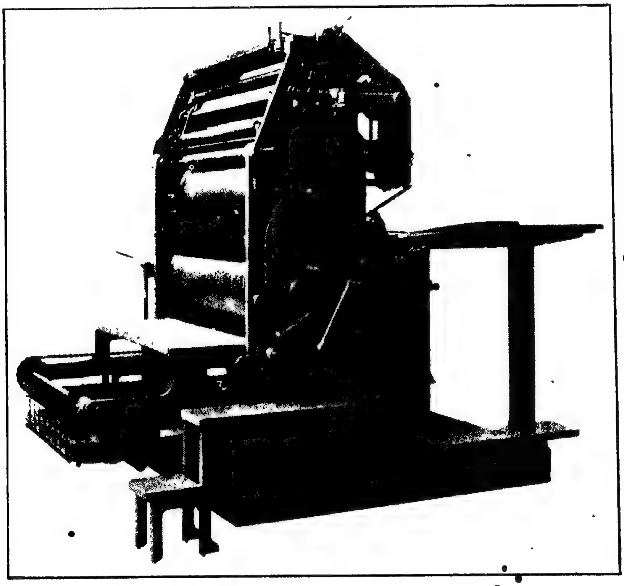


FIG. 85.—The Waite Rotary Offset Machine.

regulated with the utmost delicacy, while the press is running. The impression can be checked by hand or foot, this action simultaneously checking the water and ink supplies, while provision is made whereby either impression, water, or ink can be checked independently. The cylinder is automatically checked at the right position, just before the printing surfaces meet, thus minimizing waste of sheets.

Both plate and blanket cylinders are freely accessible without removing any rollers. The plate clamps allow of the plate being rapidly changed, and the plate tension being self-adjusting, all danger of stretching the plate by over-screwing is obviated. The rubber blanket can be quickly fixed and the proper tension secured.

The register cylinder gearing ensures that the three cylinders shall run together in absolute register. The makers particularly claim that tints and solids can be printed perfectly on this press, without a trace of gear marks.

The sheet is under gripper control from feed to delivery, being delivered printed side up without anything touching the printed face. No tapes are employed. Automatic guides jog the sheet straight on the delivery table.

The overall dimensions of a demy machine, to print sheets 23 × 18 in., are 5 ft. 3 in. × 5 ft., the height being 5 ft. 9½ in. The speed is only limited by the capacity of the feeder.

The L. & M. Rotary Offset Machine.—The L. & M. Rotary Offset Machine (Fig. 86) is a two-revolution machine, that is to say, the impression and transfer cylinders make two revolutions to each revolution of the plate cylinder. This means that there is greater time for the feeder to lay the sheets than is the case with a single-revolution machine. For example: with a single-revolution press running at the rate of 2000 per hour, the maximum time available to feed a sheet is 0·655 secs.: with the L. & M. Rotary Offset, running at equal speed, the maximum time is 1·11 secs. Obviously this gives the feeder of the latter a better chance to get perfect register at high speeds. This is most important in colour printing, in which dead register is imperative.

The delivery is by chain and gripper bars, which, by a patented variable speed device, deposit the sheets accurately on the delivery-board, due to its slowing down and checking the impetus of the sheet being carried. The delivery-board is arranged to roll out on tracks when and as far as required, so that the machineman can stand between the board and the offset cylinder, and when the delivered sheets have been removed, it can be rolled out until it hangs from the one end of the tracks, or it can be conveniently removed from the machine.

The impression cylinder is fitted with a smoother-brush, which is arranged to drop after the front edge of the sheet has passed, so preventing the edge of the sheet from being turned back, a common occurrence when a rigid brush is fitted.

The trip mechanism is a modification of that adopted on the direct rotary machine by the same makers, and has been adapted to suit the high speeds of this machine. The rollers

are automatically raised when the press is tripped, care having been taken to ensure that the plate is clear of the rollers when they are raised, and they are dropped in the correct position to ink the plate thoroughly. It is obvious from this that no partial or double inking can take place when the press is tripped. This ensures that the first sheet printed after tripping is equal to the last one printed.

The offset cylinder is provided with special reel rods to ensure even tension on the rubber blanket. These rods are fitted with pins to engage holes punched in the blanket, and a

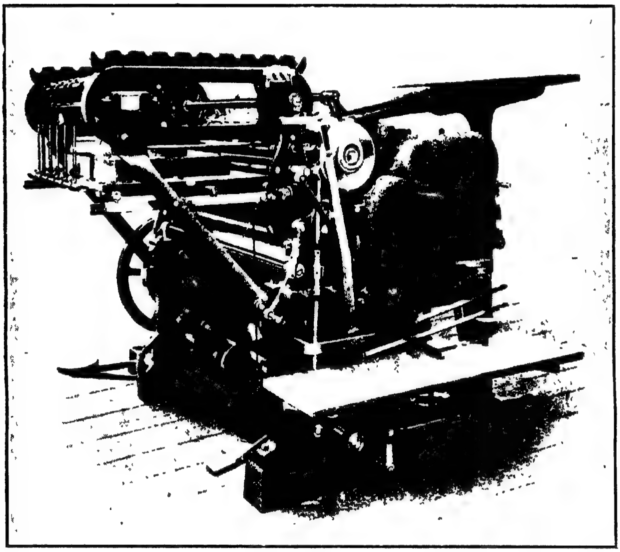


FIG. 86.—L. & M. Rotary Offset Machine.

clamp to hold it. A special gauge is supplied for use when punching the holes, and is so arranged that the setting is always made from one edge of the blanket; by that means absolute parallelism is secured between the two rows of holes. For tightening the blanket a special mechanism is fitted to the reel rods, which enables the minder to adjust the tension accurately.

The transfer cylinder is accessible both for washing and for putting on the rubber blanket. For the latter operation the delivery-board can be taken off, leaving the cylinder quite clear. There is a pedal conveniently situated controlling the backing-

up motion, which can be used when washing or otherwise attending to the blanket.

The plate cylinder is journalled in bearings rigidly attached to the side frames, and is twice the size of the impression and offset cylinders. When the plate is in position there is ample surface exposed for a proper examination to be made, and to enable it to be washed or gummed by the machineman.

When seated on the swinging seat the machineman's right foot has control of the backing-up motion pedal, a slight pressure on which is enough to move the machine to any position required. His right hand can manipulate the water-motion lifting-handle, and, as this has been carefully balanced, it is extremely easy to operate. On his left the machineman has the forme-rollers lifting-handle, the ink ductor roller trip-rod, and the water ductor roller trip-rod, which gives him a complete control of water and ink. The setting of the ink-feeder is placed at the left-hand end of the ink-duct. The water-motion ductor setting can also be easily reached.

The ink-duct is of special design. Screw adjustments are given for setting the whole of the blade. Ordinary screws for local adjustment are also provided, but are so arranged that when removing the fountain blade and back, all the local setting screws come away also, which enables the operator to remove and replace the parts without disturbing the setting. Screws are also provided for adjusting the complete fountain.

The distribution of the ink is effected by a distributing drum, three distributing rollers, three rider distributing rollers, two transfer rollers, two vibrator rollers, four forme rollers, and a ductor roller. The water motion consists of two forme rollers, a vibrator roller, a ductor roller, and a fountain roller.

The Furnival Rotary Offset Press.—This press (Fig. 87), made by Furnival & Co., Ltd., has strong frames securely bolted and stayed together on a solid base plate, and is absolutely without vibration on the top speed. It has three cylinders of equal diameter, which are made as small as possible, consistent with good printing, to enable the highest speed to be attained. The impression cylinder makes one revolution to one impression, the advantage of which is obvious. This press will give 5000 impressions per hour.

The cylinders are ground perfectly accurate to give a uniform periphery, a most important point in offset printing. The transfer and impression cylinders run in eccentric journals, and are so arranged that when the feeder depresses a pedal, these two cylinders separate, and the contact with the plate cylinder is automatically broken; in other words, the contact between all three cylinders is broken. At the same time there

is an arrangement whereby, by hand, the transfer cylinder can be put in and out of contact with the plate cylinder while the cylinders are tripped. The advantage of this method will be obvious. The plate cylinder is fitted with the usual plate clips and plate-shifting device, the latter being most useful when the plate is clamped to the cylinder out of register, back to front.

The transfer cylinder has a very simple blanket-stretching device, whereby an equal tension on all parts of the blanket is attained. The impression cylinder, of course, carries no covering. The pressure is regulated by means of micrometer

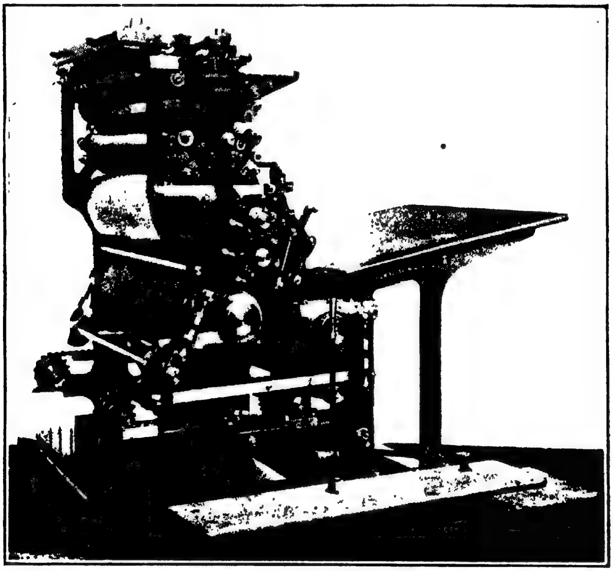


FIG. 87.—Furnival Rotary Offset Press.

nuts. The inking and damping are similar to those on the direct rotary machine of the same makers. The damper does not protrude in an inconvenient manner over the feed-board. The inking rollers are so arranged that, when the cylinders are checked, the rollers lift automatically, and at the same time the supply is stopped. It can also be checked and unchecked by hand at any time. The sheet is conveniently delivered, printed side up, by grippers, and the delivery-table is fitted with a jogger. The machine can be fitted with an automatic feeder.

The Harris Automatic Rotary Offset Press.—This American machine is capable of attaining the speed of 5000 impressions an hour. It is equipped with an automatic feeder, which forms an integral part of the press. It also has an automatic trip, or throw-off device, which immediately places the press out of action after the last sheet of paper has left the automatic feeder. This throw-off device also comes into operation should more than one sheet of paper be fed up to the printing cylinder by any chance.

It is equipped with split gears, bearers, and register racks, which enable it to give hair-like register and eliminate the possi-

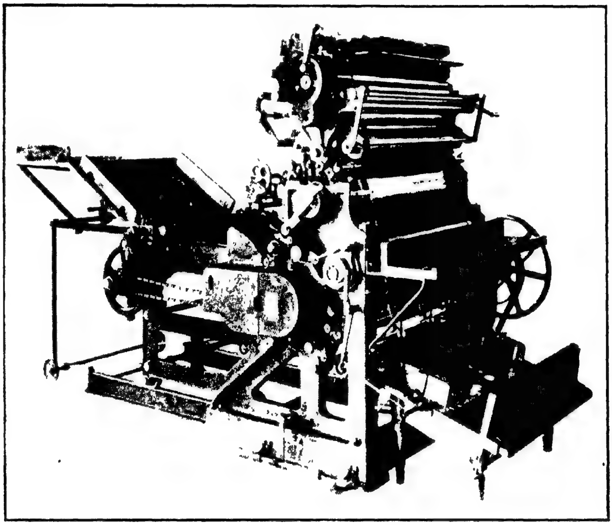


FIG. 88.—The Harris Rotary Offset Press with Automatic Feeder.

bility of gear marks or streaks appearing on the finished work. There is a specially constructed positive chain delivery, or jogger delivery, which presents a full view of the work as it is being delivered. (See Fig. 88.)

The Scott Six-roller Offset Press with "Dexter" Feeder.—This American machine (Fig. 89) is especially designed to meet the demand for large offset presses for fine colour work. The standard size is the No. 4, taking sheets up to 38 × 52 in. This is a particularly desirable size both for ordinary litho and

catalogue work, as it takes on the 36 × 52 in. and 38 × 50 in. standard sheets.

The makers claim for their six-roller distribution that it is capable of giving the densest solids, or the most delicate tints, and all intermediate effects, with absolute perfection. The ink is applied to the plate by six 3-in. forme rollers, over which are carried four small oscillating cylinders. These are connected with each other, and with the large oscillating distributing drum by four 3-in. distributing rollers. There are three 2-in. distributing rollers, each equipped with a steel rider roller, which cut up the ink on the large oscillating drum; and another 3-in. distributor, also carrying a steel rider, transmits the ink to the large distributing drum from an auxiliary distributing cylinder, which receives the ink from the fountain by way of 2½-in. ductor rollers. The complete distribution, therefore, consists of one ductor roller, eight distributing rollers, and six forme rollers,

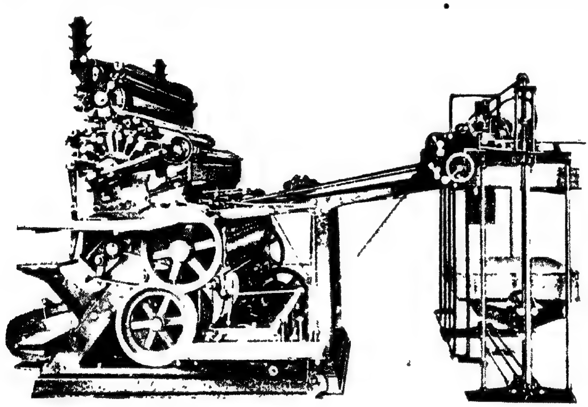


FIG. 89.—The Scott Six-roller Offset Press with "Dexter" Feeder.

all leather-covered: in addition to which there are four steel rider rollers, one auxiliary distributing cylinder, one large oscillating drum, and four forme roller oscillators. The distribution is so arranged that when light-inking jobs are run, it can be operated as a 2, 3, 4 or 5-forme roller press, with a corresponding decrease in the number of rollers, cylinders, etc. to wash up, which is an important consideration.

This press is equipped with a patent Combination "Ratchet and Continuous" Regulation, by means of which either style can be used. If the ink is a kind that requires "working" in the fountain, the pressman can save considerable time by using the

continuous attachment. This device enables the fountain roller always to turn a considerable amount, irrespective of the amount of ink "ducted," because the dwell of the ductor roller on the fountain roller is lengthened or shortened to feed more or less ink. If the ink is "short" and constant motion in the fountain is undesirable, the ratchet is set to move the fountain roller only as much as is necessary. Any intermediate adjustment between the ratchet teeth can be obtained by changing the length of the dwell of the ductor, exactly as when the continuous type is in use. By this combination any desired effect is secured.

The cam which opens the delivery grippers to drop the sheets is adjustable while the press is in motion, so that the delivery can be set to suit exactly the paper being run and the speed of the press. This is a great advantage on a large press, which is usually started up and run at a comparatively slow speed until the water and ink are working right and the register is adjusted, when it is put up to speed.

George Mann & Co.'s Two-colour and Perfecting Rotary Offset Machine.—This machine (Fig. 90), constructed by George Mann & Co., Ltd., has the remarkable feature of being able to print at one operation either (*a*) two colours on the front of the sheet; or (*b*) the same colour front and back; or (*c*) different colours front and back. The name *perfecting* denotes that it prints both sides of the sheet at the same run through the machine. The plate cylinder, which is of large diameter, has surfaces and clamps to hold a plate on each half of its circumference. Running over and in contact with this cylinder there are two distinct sets of inking and distributing rollers, each complete with its own ink supply. Each set of inking rollers automatically falls to its plate and lifts to avoid contact with the opposite plate, the gap in the cylinder which is necessary to accommodate the clamps giving sufficient time for this movement to take place. The blanket cylinder is of the same diameter as the plate cylinder and carries two rubber blankets corresponding with the two plates, each blanket taking an impression from its own plate. The impression cylinder is half the diameter of the blanket cylinder, so that when the sheet is carried round twice an impression is received from each blanket on the face of the sheet. In the case of perfecting, a small adjustment allows the gripper to open at the second revolution of the impression cylinder, instead of at the first. By this means the first blanket gives its impression to the blanket on the impression cylinder; the sheet is then taken by the gripper and receives an impression back and front simultaneously at the point of contact between the two cylinders.

A foot-pedal is conveniently placed, which, when depressed

by the feeder, causes the cylinders to part, thus raising an

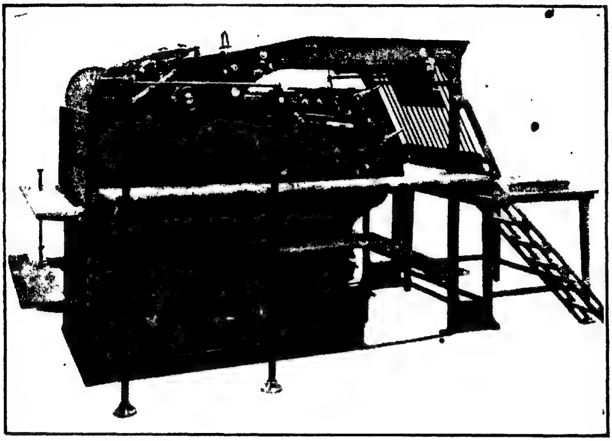


FIG. 90.—Mann's Two-colour and Perfecting Rotary Offset Machine.

FIG. 90*a*.—Mann's Two-colour and Perfecting Rotary Offset Machine: Another View.

impression; at the same time the inkers automatically lift from the

plate, and the ink and water ductors are checked. The clamps for the plates are so arranged that they can be moved in any direction. The caps of the clamps are held open by springs while the plates are being changed.

The special arrangement of forme rollers, with high-speed distributing drum, gives a perfectly broken and continuous supply of fresh ink to the plate. A very convenient arrangement with the forme rollers allows of either set of rollers working on either plate. The utility of this device will be evident to all, as in many jobs the washing-up of at least one set of rollers can thus be avoided.

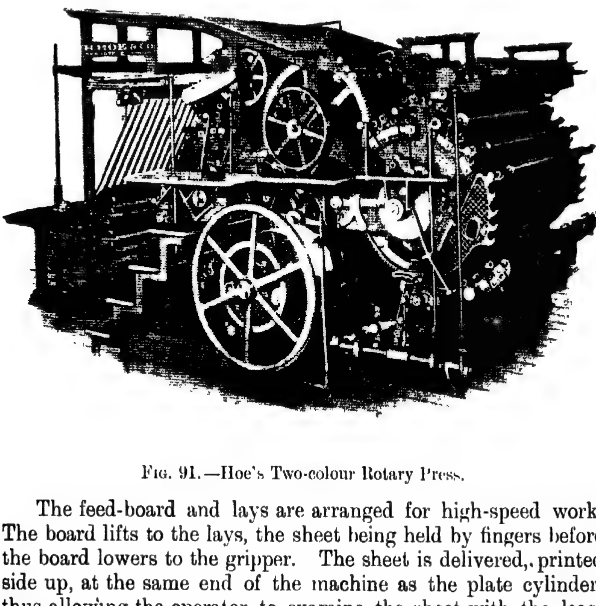


FIG. 91.—Hoe's Two-colour Rotary Press.

The feed-board and lays are arranged for high-speed work. The board lifts to the lays, the sheet being held by fingers before the board lowers to the gripper. The sheet is delivered, printed side up, at the same end of the machine as the plate cylinder, thus allowing the operator to examine the sheet with the least possible trouble or loss of time.

A special register device ensures that the cylinders shall print in dead register, whilst the fact that the gripper holds the sheet for both impressions is sufficient to prove that the two colours must register perfectly mechanically.

The machine is supplied in four sizes, namely, quad crown, extra quad crown, eight crown, and extra eight crown, the sizes of the sheets being respectively 45 × 33½ in., 48½ × 34½ in.; 65 × 44 in., and 65 × 48 in. The maximum speed

of delivery is 1300 per hour on the larger machines, and 1800 on the smaller. The space occupied by the largest machine is about 20 by 12 feet, and the gross weight is 13 tons, 15 cwt. A 7 h.p. motor will drive the two smaller sizes, but a 10 h.p. motor is required for the two larger sizes.

R. Hoe & Co.'s Two-colour Rotary Press.—In this colour press the plates on each cylinder are inked by eight rollers, with distributors over them, receiving their supply of ink from oscillating distributing cylinders. Each plate cylinder has an inking surface, an arrangement which, with the oscillating cylinders that receive the ink from the fountain, gives perfect ink distribution. The inking surface and the forme rollers can

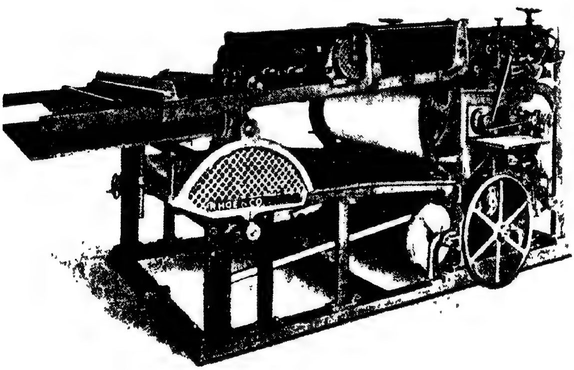


FIG. 92.—Hoe's New-pattern Two-colour Rotary Press.

be inked up without inking the plate. When the press is stopped, the rollers are automatically raised from the plate, thus preventing the streaking of the plate by the forme rollers remaining in contact with it, and by touching a treadle conveniently placed for the feeder the ink rollers can be raised or lowered automatically at will. The gripper motion is of an improved type, ensuring perfect register. The plate cylinders are provided with clamps, which grip the plate along its whole length without buckling it, and the clamps are so arranged that the plate can be readily adjusted laterally, circumferentially, or diagonally. (See Fig 91.)

R. Hoe & Co.'s New-pattern Two-colour Rotary Press.—In this improved type of two-colour press (Fig. 92) there is one large impression cylinder and two plate cylinders. The sheets are fed to the under-side of the impression cylinder, printed side

down, and are delivered from the upper side of the cylinder printed side up, nothing coming in contact with the printed surface while they are being delivered. The plates are inked by four rollers carried in frames, which can be swung away from the cylinders for ease in placing and removing the rollers. The plate cylinders make two revolutions for each impression, and the plates are therefore inked twice. The impression cylinder can be tripped by the feeder. The delivery-board is arranged so that it can be lowered as the height of the pile of sheets increases, and can be quickly raised when the pile is taken off.

The motor for driving is placed underneath the feed-board, driving by belt with a pulley on the driving shaft. A $7\frac{1}{2}$ h.p.

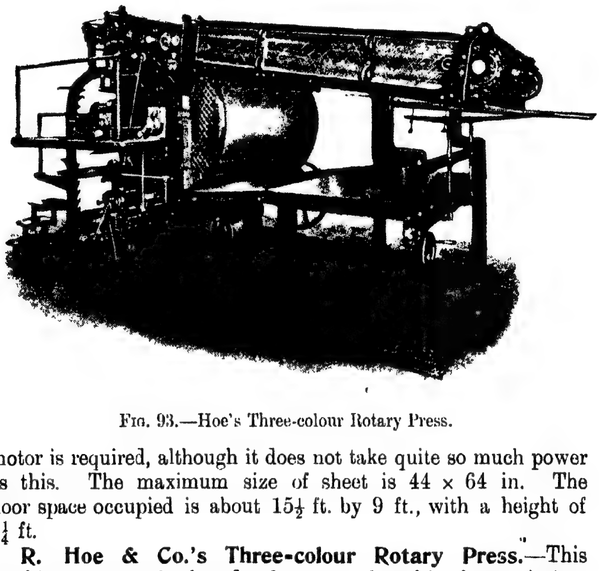


FIG. 93.—Hoe's Three-colour Rotary Press.

motor is required, although it does not take quite so much power as this. The maximum size of sheet is 44 × 64 in. The floor space occupied is about $15\frac{1}{2}$ ft. by 9 ft., with a height of $7\frac{1}{4}$ ft.

R. Hoe & Co.'s Three-colour Rotary Press.—This machine shows a further development of multi-colour printing. Four forme rollers are provided on each of the two plate cylinders, and as these cylinders make three revolutions to one printing, they give an equivalent of twelve forme-inking rollers. The colour is thoroughly distributed before being applied to the forme rollers. The damping movement is adjustable by hand-wheel from maximum to minimum supply. The feeder stands on the floor, instead of upon an elevated platform, and thereby has greater freedom and control of the press. The improved feed motion gives perfect register.

The cylinder is tripped at any time, automatically, by a foot treadle, requiring only slight pressure of the foot to actuate it. The patent front delivery takes the printed sheet and deposits it, printed side up, on the delivery-table, which is adjustable in height. No tapes or surfaces whatever can come in contact with the print.

CHAPTER XXI.

MACHINE MANAGEMENT.

Method, Order, Cleanliness.—A machineman should, above all things, be methodical at work. Method is of great assistance in many ways, and is one of the first things that will help to create in the mind of the young man an affection for his machine and an interest in his work generally. Without method work becomes a vexation and a worry.

The machineman should be provided with all necessary accessories, and he should never be at a loss to know where to find them. Borrowing should be a thing almost unknown to him, for the man who is constantly seeking favours from his neighbour is the man who makes but little headway. His machine should be properly oiled at regular intervals, the lubricating cups should be always kept well supplied with oil, and while taking care that a sufficient quantity of oil is getting through for the purpose, he must see that it does not run to waste. If the oil is running through too quickly, a piece of felt or some coarse worsted must be placed at the bottom of the cup so that it will filter through only very gradually and lubricate the journal drip by drip.

To obtain the best results from a machine, it must also be kept clean and tidy, and the immediate surroundings should not be neglected. Soiled cotton waste, rags, waste paper, etc., should be put into receptacles specially kept for the purpose and not thrown about upon the floor. It must not, however, be inferred from this that the machineman should waste his time with emery cloth and polishing paste; far from it, but it is absolutely essential that the working parts of the machine should be kept free from dirt, the oil holes kept clear, the brush and grit-guard kept free from fluff and grit from the paper, and the delivery and feed boards dusted daily. The machine will then not only look well, but it will print well. *Method, order, cleanliness*, then, must be the watchwords of the planographic machineman.

Requirements of the Machineman.—The machine attendant is known as the *machineman*, *machine-minder*, or *pressman*.

He should be a person of superior technical skill, not only possessing a knowledge of machine construction, but also equipped with a thorough training in lithography, obtained by practical experience in the transferring and proving departments of the workshop, or by an all-round course of hand-press printing in conjunction with transferring. It has been remarked that the machineman is practically a part of the machine, the inference being that planographic machinery having been brought to such a high standard of perfection, very little else is required to enable it to do the printing. Nothing, however, could be farther from the truth than such an idea, because the higher the standard of perfection reached in the machinery, so will a corresponding standard of skill be demanded of the attendant. A machine is of little use without a skilful and capable man in charge.

Acquaintance with the Machine.—Upon being given charge of a machine the young machineman should go over it in detail and become acquainted with the various parts. Generally speaking, the principles that apply to a flat-bed machine also apply to a rotary machine, but it is hardly to be expected that a young man will be given charge of a valuable machine of the rotary type without first having gained some experience on the slower, simpler, and less valuable flat-bed machine. Therefore while the rotary machine may be referred to in this chapter from time to time as occasion requires, the education of the young pressman will, for some time to come, be acquired on the flat-bed. While going over the machine he should take special note of the bolts and nuts and see that none are loose or likely to come out while the machine is running.

Attention to the Cylinder.—The cylinder should next receive attention. First, lift up the sloping feed-board and remove the cylinder coverings, which is done by loosening the tail ends first, that is, the opposite ends to the gripper. Slightly tighten the rod to release the ratchet, and then unwind it. Next, unhook the gripper springs and open out the gripper, when it will be seen either that the cylinder coverings are held between two plates screwed tightly together, or that they are hooked on to hooks and carry a stout wire inserted in-and-out fashion through the holes to give resistance to them while the blanket is being tightened up to the cylinder. Whether there is more than one cover will depend entirely upon the thickness of the material used. It will now be seen whether the face of the cylinder requires attention. It is no uncommon thing, when non-waterproof materials are used as cylinder coverings, for the damp to get through and create on the cylinder an accumulation of rust. This, if allowed to remain, would soon affect the

printing through uneven pressure; so it must be removed with emery cloth and oil, and measures taken to prevent its recurrence, as the evenness of the cylinder would soon become affected by successive scourings. The oil holes in the cylinder and its accessories should also be looked to, and all parts carefully oiled.

The Cylinder Brush and Grit-guard.—The cylinder brush is a very necessary adjunct to the flat-bed machine. It is situated close to the cylinder and immediately below the gripper, and its purpose is to prevent doubling or blurring of the work. The sheet is fed into the gripper in an almost upright position, and as there is a considerable distance for it to travel before it reaches the printing surface, a thin paper will show an inclination to sag and touch the work in places before its proper time; so the brush, which extends right across the cylinder, must be adjusted to hold the sheet sufficiently close and tight to prevent this sagging or dipping, but not so tight as to drag the sheet. If a grit-guard is fixed on to this, its usefulness will be considerably enhanced by gathering grit, fluff, etc., which may come off or from between the sheets. This grit-guard is made by fixing a sheet of rolled or other card to the inside of the upright bars that hold the brush in position. It should extend the full length of the cylinder, and be of sufficient depth to come right on to the brush, with a little bit extra to form an angled receptacle, which should cover the brush almost to the tips of the bristles. This will collect grit and fluff, which might otherwise get on the rollers and cause considerable trouble.

The Cylinder and Flywheel Brakes.—The brakes are very important parts of the mechanism of a flat-bed machine. There are two of these, the more important being the cylinder brake, and the less important one the flywheel brake. The usefulness of the cylinder brake is demonstrated just before the cylinder takes the printing surface by "staggering" or drawing the gearing together, thus ensuring perfect register. It is also useful as the cylinder leaves the stone after the sheet is printed. Were it not for the drag exercised by the brake at this particular moment, the cylinder would, owing to the sudden release of pressure, come home with a nasty jerk. The air-cushioning cylinders which are now put on most large machines lighten the work of the brake considerably. Only just enough brake should be applied to prevent the cylinder coming home with a thud, i.e. the cylinder should slip home easily, quietly, and naturally. The flywheel brake is intended to prevent overrunning when the machine is pulled up. These brakes get out of order and become more or less ineffective through inattention to the leather on the brake shoes. The shoes should

be taken off and the leather examined. If it is in a hard, dry, glazed condition, it should be scraped or filed with a coarse file until it has been made somewhat rough. It should be soaked with castor oil and then replaced.

The Flyer Drum.—This is a small cylinder in connection with the delivery apparatus. It is situated just under the feed-board close to the top of the impression cylinder. Its special function is to snatch the printed sheet from the cylinder as it comes round, transfer it to the travelling tapes and thence to the flysticks, and finally to the delivery-board. It should be taken down from its position, the tapes removed, and if necessary washed, and the rubber rings below the finger grippers should be renewed or turned round to an unworn part. The position of the cylinder, which is usually indicated by corresponding marks, should be carefully noted before removal.

The Gearing.—There is a considerable amount of gearing on all types of planographic machines, but the rotary offset machines have more than the others owing to the extra cylinder, and it is very important that the spaces between the teeth should be kept free from dirt to ensure smooth running. The geared racks which run along either side of the stone carriage and ink slab are especially liable to accumulate dirt, fluff, cotton waste, etc., which must all be cleaned out. All gearing should be lubricated with tallow or other solidified oil.

The Stone or Bedplate Carriage.—The stone carriage is usually supplied with one ply of special cork bedding to give resiliency while the stone is under pressure, and this is covered with a sheet of stout zinc. These should be removed, the iron bed examined, and all dirt that may have accumulated round the edges must be cleaned out. The screws for raising and lowering the iron bedplate should then be turned, and the bed raised until it will go no farther. Then lower it by giving each screw a few turns alternately, and take care that the plate does not jam and allow the supports to leave it. If it does, the cause must be looked for. It is not advisable to oil and grease this part of the machine, but it must be kept clean and made to work freely.

The Under-parts.—The under-parts of the machine must also receive their due share of attention. Among these may be included such important parts as the main driving and spur wheels; the journals and their bearings; the driving shaft and connecting-rod, with their important oil holes at either end; the steel rollers that support the stone carriage and ink slab; and the rails upon which they run. All these require to be kept clean and carefully oiled.

The Side Rails.—These are the polished parts running along

either side of the machine at the top of the frame, between which the stone carriage travels very closely to ensure register and prevent swaying. It is most important that these should be lubricated two or three times a day with either machine oil or a solidified oil such as tallow or vaseline.

The Air-cushioning Cylinders.—The air-cushioning cylinders, or air buffers, are designed to assist in reversing the carriage when the machine is in motion, and also to lighten the work of the brake. They should be lubricated with an oil having a good body, such as castor oil. The leather on the plungers should be soaked occasionally with the same oil, as it must be kept in a soft pliable condition, and not allowed to become hard and dry.

The Ink Duct.—The ink duct (Fig. 94A) is a box arrangement used for holding a supply of ink, and is situated across the top of the rear end of the machine parallel to the ink slab. It is formed by a steel roller at the front, with a broad flexible blade

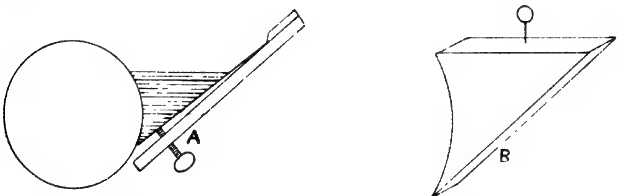


FIG. 94.—Ink Duct (A) and Ink-separating Lead (B).

resting on an iron support at an angle of about 45 degrees, through which thumb-screws run for the purpose of regulating the flow of ink by increasing or diminishing the space between the edge of the blade and the duct roller in front. In regulating the ink flow care must be taken not to have any part of the blade pressing unduly against the roller, as this would soon result in the blade becoming worn in places, and excessive tightening is quite unnecessary. It will, however, be necessary to have some lead or plaster of Paris castings made for the purpose of confining the ink in the box to the parts where it is most required, or for separating the inks when working with more than one colour at one printing (Fig. 94B). The castings should be made directly in the box, but before the lead or plaster sets, a screw nail should be inserted half-way in, so that it may afterwards be used for convenience in handling, or as an easy means of keeping the castings in position by the aid of a piece of thin wire or string twisted round the nails and extended from one to the other. The castings should be of various thicknesses, ranging from a quarter of an inch to one and a half inches.

The Water Duct or Fountain.—The water duct or water fountain is a trough used for the purpose of holding a supply of water, which, like the ink duct, gives out its contents in regular quantities with each traverse of the machine. It may be situated just in front of the cylinder, in conjunction with the damping rollers or not, according to the make of the machine. A brass roller revolves in the centre, and communication is maintained between it and the damping rollers or the damping slab by means of a vibrating damping roller, which should be a covered one. The trough should always be kept clean and supplied with pure water.

The Damping Slab.—The condition of the damping slab or damping table, as it is sometimes called, is of almost equal importance to that of the damping rollers. It consists of a solid board of the same length as the rollers and about 18 in. broad. To be effective, it must be dead level. The board as well as the covering will require to be renewed from time to time, although the former may last for some years if it is taken off and planed level occasionally. It is a good plan to coat the wood when it is new, or after planing it, with a little turps and creosote as a preventive of rot. This will also have a beneficial effect on the coverings, which should consist of one or two plies of thick felt, and on top of this a ply of best quality moleskin. White tinned rustproof tacks should be used for tacking on the coverings.

The Machine Belts.—There are usually two belts to each machine, but not always, as sometimes the machine is driven from the main shaft instead of from a countershaft. A crossed belt, that is, a belt that has been crossed between two pulleys in a manner to form the figure eight, possesses a greater driving power than a straight or uncrossed one, by reason of its gripping more of each pulley surface. These belts may be made either of leather or of cotton, and are manufactured differently by the various makers. It is better to have a belt with plenty of power behind it, that is, with breadth and weight, than to have a thin narrow one that is too weak for the work.

The Cylinder Coverings.—If everything is now considered satisfactory, the cylinder coverings may be replaced. These may consist of materials of various thicknesses and qualities, or there may be one thick blanket only. There is a difference of opinion regarding the best material to use for this purpose. The rubber blanket is considered by many as unsurpassable for all types of planographic machines, and there is no doubt that splendid results may be got when thin paper is printed; but it loses some of its printing quality with a thick paper, and it is very expensive and liable to damage. Rubber blanket consists of two or three

plies of fine canvas solutioned together and finished with a thick uniform coating of pure indiarubber on top. Another good covering is made by using a three-ply rubber canvas blanket, which is exactly the same as the rubber blanket, but without an indiarubber facing, and on top of this a black glazed American cloth. This certainly makes a first-class cover, and is much more economical to use than the rubber blanket, but it demands an even, regular printing surface, as it cannot dip into hollows like a good rubber blanket. A printer's thick flannel blanket covered with a glazed American cloth is also useful, but is not so good as the two already mentioned. On a rotary offset machine only a rubber blanket will do.

CHAPTER XXII.

MACHINE PRINTING FROM STONE.

Setting the Stone.—As no two stones are alike for thickness it is necessary to set each one to suit its own requirements. This is done by first testing it all round with the callipers, and then making up any deficiency in thickness with plies of thin wrapping paper, fanned out in such a way as to form a gradual taper. It is better to place the packing between the iron bed and the cork bedding, as this will help to lessen the risk of breakage from this source. Always remember at this stage that the stone should be set very slightly higher at the front edge, that is, the gripper edge, than at the back. There is more than one reason for doing this. In the first place, if the stone were set otherwise, the cylinder would leave it at each impression with a thud that would not be in the best interests of the machine, and the cylinder coverings would soon be spoiled by the back edge of the stone cutting it. There is also the risk of the stone becoming loose by reason of the excessive pressure on the back causing it to tilt at the front, which would gradually have the effect of loosening the screws. The register would also be affected by the distortion of the paper.

Having slipped the stone into the carriage, lower it by turning the pressure screws until it is below the geared rack on either side, and then take the carriage to the back of the machine, release the cylinder check, and turn the flywheel again until the cylinder has turned halfway over the stone. Now turn up the pressure screws until the stone is jammed tight against the cylinder at either side, but as this will not be quite up to printing pressure the cylinder must be brought round to its place and the pressure again raised very slightly, when the pressure screws may be temporarily jammed. The stone may then be brought up to within a couple of inches of the front edge of the bed and centred exactly the other way; then fit in suitable blocks and tighten the screws just enough to hold the stone in position while an impression of the work is taken.

Mixing the Ink.—Lithographic ink as a rule is not quite ready for use as it comes from the maker. Even the strong

colours, such as black, red, and blue, although they are to be printed full strength, require to be thinned and altered to suit the various working conditions. In other words, the inks are bought from the maker in concentrated form. Owing to the multifarious nature of lithographic work generally, this is by far the handiest and most economical way of obtaining and using them; indeed to purchase them in any other form, except for special work, is simply out of the question. The most useful inks for general work are (1) Black, (2) Crimson Lake, (3) Pure Blue, (4) Yellow Chrome, (5) Burnt Sienna, and (6) Burnt Umber. With crimson lake, pure blue, and burnt sienna nearly all the shades of browns and greys right up to a soft black may be made by mixing them in different proportions along with a greater or less quantity of medium. In mixing inks the same principle should be kept in view, whether they are to be used as strong body colours or as delicate tints: they must be mixed with a medium that will hold the colour in suspension and not allow it to separate and fall to the bottom, or to print so that the medium would be absorbed by the paper while the pigment would be left on the surface as a dry powder. The proper mediums for this purpose are the *lithographic varnishes*, which should be guaranteed to be manufactured only from pure Baltic linseed oil boiled to various degrees of thickness, and the mediums known as *tinting medium* and *tinting white ink*, which are made chiefly from alumina white and are used in conjunction with extra thin or thin lithographic varnish which, when coloured with ink, forms a printing ink tint.

Inks should be of easy, sloppy, or buttery consistency, not stringy; they must not work greasy, yet they must contain a sufficient amount of grease to feed the work as the printing proceeds. When inks are required to be printed up to their fullest possible strength of colour, they must be reduced with boiled linseed oil, such as painters use for thinning their paints, but only in such small quantities as to reduce the ink to working consistency and no more. Especially is this the case with inks intended to dry with a lustre, such as bronze blue ink. To reduce this beyond a certain point would destroy the lustre; so a very thin reducing medium must be used. Ink to be used for printing bronze work must be made up with a good body of colour, that is, an ink carrying a full proportion of pigment, and it must be one that will dry hard and quickly on the surface of the paper. It must also possess adhesive qualities so as readily to catch the bronze dust as it is passed over the surface of the sheet. A useful ink for bronze work may be made by mixing one part yellow chrome ink with two parts burnt umber ink, using as a reducing medium a mixture of equal parts of thin

litho varnish and copal varnish, to which has been added a little gold size or terebene. The chief point to keep in view is to work the ink with a good body of pigment, which, however, must be regulated by the quality of the paper. Some papers will stand a much stronger ink without plucking than others. If the ink is made too thin, there will be a considerable risk of its sinking into the paper and leaving the pigment and bronze powder on the surface, only to come off later as the work is handled.

Ink for Bright Enamel Papers.—The printing requirements of bright enamel papers differ from those of dull papers, and also from those of plain uncoated papers. Inks that might print quite satisfactorily on the two latter kinds might prove fatal on the former by refusing to dry or adhere to them. Sometimes the ink may be easily removed from bright enamel papers, months after the printing has been completed, by simply rubbing lightly with the finger. An ink to be used for this purpose must possess characteristics similar to those required for printing bronze work, that is to say, it should be used as strong as the nature of the work and the paper will allow. It must have strong adhesive qualities, and contain sufficient driers to enable it to dry hard and quickly. The colour should be of such strength as to allow the ink to be worked very sparingly. If, after the work has been printed for several days, it is found that the ink has refused to dry or bind itself to the paper, have the sheets dusted over with French chalk, when they may be handled immediately afterwards.

Washing Out the Work.—The stone at present is coated with a coating of dry gum arabic or Arobene, which must be washed off with clean water, the superfluous water being wiped down with the damping cloth. Now gum it over with a little thinnish gum and wipe it down with a *dry* cloth until only a thin even film is left, which must be fanned dry. If the work is of a heavy nature and contains a lot of ink and resin, wash it away first with turps or naphtha containing a little grease, using no water or damp cloths, and then pour on some asphaltum solution, spreading it quickly all over the stone, and rubbing it in firmly but evenly. It may be left at this stage until the inking and damping rollers have been adjusted and got ready. Having spread a small quantity of the ink along one of the distributors, allow the machine to run until the rollers are evenly but sparingly charged; then stop the machine and wash the asphaltum from the stone with a little thin gum. The machine rollers should now be allowed to run over the stone for a few minutes while special attention is directed to the damping, which must be even and just sufficient to prevent the ink from taking on the parts where it is not wanted.

Taking the Impression.—Everything being considered satisfactory, place a sheet of the job in the cylinder grippers and pass round the cylinder. This impression will be anything but perfect. It will lack both ink and pressure, and the work will not be in position, which will necessitate re-adjusting both the side lay and the stone. The same sheet might now be passed through again, and attention given to the bushes of the cylinder for any movement while it is taking or leaving the stone. If no movement whatever takes place the pressure must be increased until the slightest indication of movement is observed on either side of the machine. Be careful never to start the machine with too much pressure. If this mistake should be made, then loosen the jam screws which hold the stone in position, lower the bed, and pass round the cylinder again before tightening them.

Once the correct printing pressure has been found it will be a simple matter in the future to obtain the same result by means of a gauge. This may be accurately done by placing a long straight-edge right across the stone carriage and on top of the gearing guards, and finding the exact distance between the bottom of the straight-edge and the stone by means of a small wooden wedge, which must be marked at the spot where it comes into contact with the straight-edge.

A Register-finder.—A register-finder may also be easily made. When the first printing is finished, take a printed sheet and lay it, printed side to the work, in exact position on the stone. Now take a strip of card or thin zinc and place one end against the inside edge of the stone carriage (gripper side) and mark upon it the exact spot where the edge of the paper comes to. Now do the same at the side-lay end. It will stand to reason if, in the after printings, when the pressure has been obtained, this sheet is laid down in a similar manner, and the stone moved until the edges of the paper agree with the marks on the finder, the work must be in exact printing position, provided, of course, that the stone is locked up without being moved again.

Three Great Principles in Printing.—There are three great principles which must be observed by planographic machinemen. They are as follows:—

Work with the minimum amount of pressure.
Work with the minimum amount of ink.
Work with the minimum amount of damp.

The ink should be of a soft, buttery consistency, not stringy. It should contain only sufficient grease to feed the work and keep it in a healthy condition without causing the other parts to tint, and it should always contain a good full body of colour. If

the solids in the impression are printing solid, but the colour is not of sufficient strength, do not try to obtain the desired result by piling ink on the rollers, but rather strengthen it by adding more strong colour. Plain, uncoated printing papers require more pressure than enamel papers: indeed the great secret in the successful printing of enamels is light pressure.

Overlaying the Cylinders.—Overlaying is a method of patching over with paper certain parts of the cylinder, the object of which is to bring more pressure to bear, and give emphasis in printing, on these particular places. The process is better known to the letterpress printer than to the planographic machineman, but it might with advantage be imitated more, in a modified way, on either the flat-bed or the direct rotary machine. It often happens that colour work, and even black work, is required to be printed on roughish papers. The work on the stone or plate may include a range of tones varying from the lightest tint right up to the solid. Now to get sufficient ink on the rollers to enable the solid parts to print solid, it very often means that it is done at the expense of the tones, namely the three-quarter tints, the half tints, the quarter tints, right down to the very finest of the work, which all suffer through the printing appearing thick and muddy. On the other hand, if the work is printed with sufficient ink only to suit the tones, the solid portions must suffer for want of colour, and the life and sparkle the work was intended to have are lost.

As already explained, one of the great principles the pressman must keep in view if the work is to be printed in good condition is to work with the minimum quantity of ink. It is quite certain then that the work must be printed to suit the tones, and that other means must be adopted to bring up the solids and other heavy parts, and this can only be brought about by judicious overlaying on the cylinder. For this purpose the best cylinder covering is the hard, economical three-ply rubber-canvas blanket with an outer cover of glazed American cloth. To go about this properly, secure by means of fish glue or dextrine a sheet of strong, flat paper of the same size as the sheets to be printed along the gripper edge of the cylinder, making certain that the part of the cylinder cloth to which the sheet is to adhere has first been freed from grease by washing with soap and water or benzoline, or rubbed over with a clean cloth and dry whitening. When the adhesive has dried somewhat, take an impression of the work on a paper that is not too thick, and afterwards run the cylinder round again, but without a sheet this time, so that the impression is printed on the sheet adhering to the cylinder. Now carefully and accurately cut from the first sheet the parts that require to be emphasized on the print, and paste these down

in exact position on to the printed sheet adhering to the cylinder; then try another impression. A considerable improvement will now be seen on this print, but another patch or two may still be required in places to make the work perfect.

Another method that may be adopted, and in some respects a better one, is to fix to the cylinder a number of paper flaps (small sheets of paper adhering at the top end only) representing the number of pages or transfers on the forme, making each piece of paper as nearly as possible the exact size of the work. It is better to tear the flaps to the size required than to cut them, as the sharp sudden edges left by the scissors will cause an indentation to appear on the backs of the printed sheets. They are simply fixed on by the top edge and afterwards passed round to receive an impression of the work, and the patches are then pasted on just as described for the first method. This method is superior to the former if anything should come off, but make certain that the parts to which the flaps adhere are thoroughly cleaned before sticking them down; otherwise they are sure to come away as soon as the adhesive becomes dry. Work on aluminium will not stand overlaying to the same extent as work on stone or zinc.

Gaining Experience.—Having obtained a satisfactory proof and received the signature or stamp of the person responsible for the quality of the printing, every effort must be made to maintain this standard. This can only be accomplished by constant care and watchfulness, and these are the only means of gaining the experience that is so essential before one can expect to be entrusted with better work, or a more expensive and intricate machine It is only natural, however, to expect that until the young pressman has gained at least a certain amount of experience, he will occasionally have trouble with his work. After the forme has been running for some time, the work will show signs of becoming slightly thickened or slightly weakened, which in either case must be remedied at once. It is not always necessary to stop the printing to effect a remedy. The principal thing is to apply the means at the very commencement of the trouble, which can only be detected by making *regular and careful comparisons* between the signed proof sheet and the impressions as they are printed.

Doctoring Thickened Work.—If the tendency is towards a thickening of the work, it is most probably due to the rollers carrying too much ink, or the ink may contain too much grease, but it may be due to the damping rollers not supplying the damp in a firm, even manner. The exact cause must be ascertained before a remedy can be effected. In the meantime, however, a slight application of the ammonium phosphate solution as recom-

mended for use on the rotary machine will be found serviceable, using it very sparingly and repeating it later if necessary. The addition of a little tinting medium or strong varnish on the rollers may help. If, however, the work has been allowed to get beyond the "tendency" stage, the machine must be stopped and the work washed out with turps, inked in firmly with a very sparingly charged black ink roller, dusted over with resin and French chalk, and then etched with nitric-gum solution of sufficient strength to produce a nice mild effervescence, after which the stone must be washed, dried, and then treated to a liberal coating of gum arabic solution, or better still, to a thin coating of Arobene, which must be fanned dry. The stone must then be washed, re-gummed thinly, and fanned dry, and the work washed out by the asphaltum method just as at the start.

Doctoring Weakened Work.—If the work shows signs of becoming weak, it may be due to any of the following causes: (1) Too much water on the forme; (2) the ink too stiff; (3) an unduly large proportion of tinting medium in the colour; (4) an insufficient quantity of grease in the ink; (5) the inking or damping rollers skidding for want of lubrication or from the skins being loose and requiring packing; (6) chemicals in the paper or the enamel. If it is due to any of the first five causes, it is as a rule not difficult to find the cause and effect a cure. If the paper is suspected of having a detrimental action upon the work, tear up a piece and soak it in a little water, mixing it about with a clean instrument such as a glass rod, and then dip into the solution a piece of blue litmus paper. If the litmus paper turns red, it will prove that the paper contains acids or acid salts, either of which will exert an injurious action upon the work and may at the same time have a sensitizing action upon the other parts of the stone, causing it to tint by taking grease from the ink. If this latter tendency is not present, a cure may generally be effected by applying a small quantity of some ink doctor in semi-liquid form to one of the ink distributers, but using only a very small quantity at a time, and repeating this at short intervals until the work again compares favourably with the signed proof.

If the stone is inclined to tint, and the work appears weak at the same time, it is almost certain to be caused by the chemicals contained in the paper, which is probably an enamelled one. In this case the stone should be gummed over with clean gum and the work charged with black ink by rubbing-up as directed on p. 88; then wash away the gum with the water sponge and clean away any tinting which may have formed on the surface by rubbing with the fingers. If the work appears to be all right otherwise, and fully charged with ink, dust it over with

resin and French chalk, etch it with nitric-gum solution of medium strength, and then treat it exactly as recommended for thickened work, but when washing it out with turps on top of the dry gum previous to applying the asphaltum, rub a little tallow or other grease into the work to strengthen it.

Paper-creasing at the Machine.—Paper may crease during the printing from various causes. The most common of these is a wavy condition of the sheets, which, literally speaking, means that they are bigger round the edges than in the centre. This is due to expansion caused by the absorption of moisture from the atmosphere. If a sheet in this condition is passed between two even surfaces, such as a stone and the cylinder of the machine, the excess round the edges must fold over or crease in a greater or less degree, according to the amount of expansion that has taken place. The cure for this is to hang the paper in small quantities over ropes or racks exposed to cool, damp air, until it has become equally affected by moisture throughout, a process which occupies about forty-eight hours. When the creasing is not very bad, it may sometimes be got rid of by gumming on to the gripper edge of the cylinder a sheet of stout, flat paper just big enough to take in the work, allowing it to hang loose at the back.

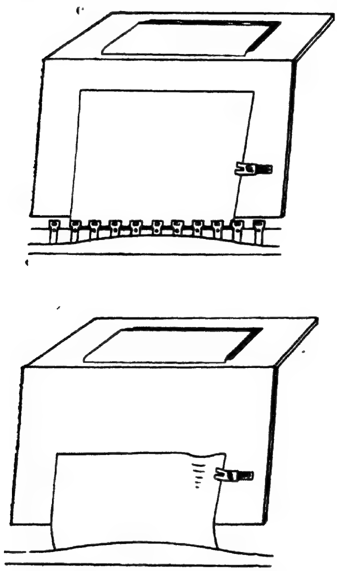


FIG. 95.—Paper Creasing Through not Being Cut Square.

Creasing often arises on a flat-bed machine from the whole weight of the sheet bearing on the two ends only, instead of being equally supported right along. The paper as it comes from the paper-mill is not always cut straight. Sometimes it happens that from certain causes it has been cut either convex or concave. If the latter, then it must stand to reason that when a sheet is fed into the gripper of the cylinder, the whole of its weight will rest on the two ends, which will have the effect of

causing it to sag in the centre, thus drawing in the back edge. This would be equal in effect to being wavy, as the gripper would close and hold it in that position. Again, the gripper rests may be at fault. Perhaps for some reason during a previous run these may have been altered, so that the sheet is now left without support in the centre. In either case the remedy is practically the same. The sheet must have more support in the centre by adjusting the rests, even though the end ones are taken away from the sheet altogether.

Creasing sometimes results from the paper being cut considerably off the square, and the sheet while passing the side-guide is pushed a little towards the centre, thus causing a kind of crinkling of the paper (Fig. 95). The machine brush may catch the sheet and hold it in this condition while it takes the stone, thus forming creases. Turning the paper round and using the opposite edge for gripping will sometimes get over the difficulty; but failing this, the paper must be cut square if the side-guide is a fixed one.

CHAPTER XXIII.

PRINTING CHROMO OR COLOUR WORK.

Interesting but Anxious Work.—The most interesting class of work printed on a planographic machine is undoubtedly chromo or colour work. It is interesting from the development point of view, because beginning with bronze or yellow, or a light grey or buff tint, and then adding colour on top of colour, we finally obtain a facsimile of the original oil painting or water colour sketch. At the same time this class of work gives the greatest cause for anxiety, because its completion seems such a long way off, and every colour printer is only too familiar with the many little troubles that crop up from time to time, and which require special treatment and attention. Even the weather has its effect upon the work, some papers being much more susceptible to weather conditions than others. Sudden changes from dry weather to damp, muggy weather often have a considerable effect upon register; and a sudden rise or fall in temperature has an effect, not only upon the paper but also upon the printing ink. Ink that may have been working anything but greasy in the morning may require considerable alteration in the afternoon, but many of these little troubles and difficulties may be entirely obviated by a little forethought.

Precautions against Bad Register.—Several precautions must be taken when commencing a job in a number of workings, all of them bearing more or less directly on the question of register. If the work in hand is a sheet of labels, maps, or suchlike, requiring dead register, the paper after being matured by hanging should be run through the machine on a clean stone or plate under ordinary working conditions, that is to say, the stone should be level, the pressure right, and the correct quantity of damp upon its surface. If slip sheets are to be used during the printings, they should be inserted now; otherwise they may be piled. For a full treatment of register, which is so important in colour work, see later in this chapter, at p. 240.

The Keystone.—It is a wise plan to put the keystone into the machine and pull some impressions, not only to secure the correct position on the sheet, but also to make certain that none

of the transfers on the first colour forme have shifted from their proper position during the process of transferring. This keystone, which, it will be remembered, was carefully laid aside by the transferrer after he had taken his key impression on the zinc sheet, is now set in the machine and a number of prints taken in proper position. It will be well to print twenty or twenty-five copies, three or four of which may be used to find the register of each of the first few colours. When these have been taken, the work may be polished off if it is only a temporary key and not to be

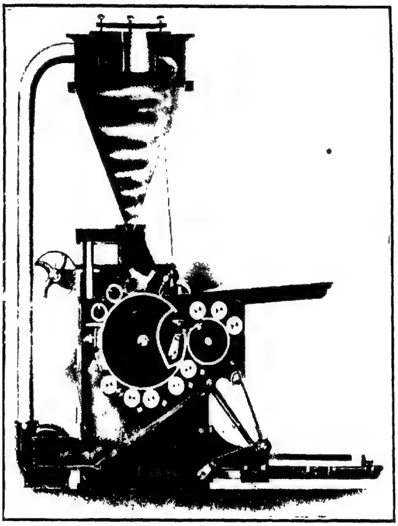


FIG. 96.—Safety Vacuum Bronzing Machine.

used as a printing. If it is to be printed at a later stage, the work must be rolled up with a sparingly charged hand roller, dusted over with resin, and gummed up.

Bronze and Metal Leaf.—A considerable proportion of lithographed colour work includes a gold working. This gold may take the form either of bronze powder or of the more brilliant metallic leaf. The bronze powder produces the more artistic effect, whilst the metal leaf produces a very showy glittering label. The former, when executed by hand, is dusted over the work while the ink is still wet and sticky on the surface of the paper, after which the sheets are dusted with clean cotton

wool. There are several machines now on the market for doing this work, the sheets being passed in to them as they are printed. They perform the whole operation of bronzing and dusting. One of these, called the Safety Vacuum Bronzing Machine (Mark Smith's Patent), is shown in Figs. 96 and 97.

The Safety Vacuum Bronzing Machine (Mark Smith's Patent).—The makers of this bronzing machine claim to have succeeded in preventing the escape of bronze dust into the air, so protecting the health of the workmen. The air and superfluous bronze pass through a part called a cyclone and are separated, the bronze returning to the feed-box, and the air escaping through a hood and pipe to the outside atmosphere, either through the roof or side wall or window. It is essential when fixing the air outlet that no obstruction should be caused by acute bends, because it spoils the action of the cyclone. All gold bronze returns to the machine without waste, but aluminium, French chalk, or whitening being so light, some escapes into the outer atmosphere; therefore it is advisable not to pass any more through the machine than is actually required by the job.

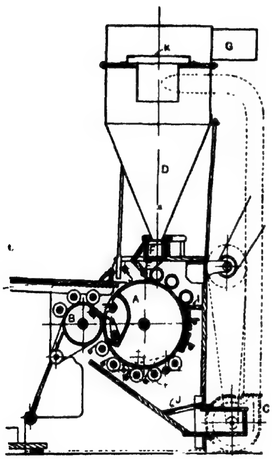


FIG. 97.—Section of Safety Vacuum Bronzing Machine.

A, Bronzing cylinder; B, Taking-off and dusting cylinder; C, Fan; D, Cyclone; E, Bronze supply; F, Collecting box that is placed when cleaning the machine; G, Bonnet which covers the outlet of cyclone to which a pipe is attached and taken through a side wall or window or roof; I, Diffusing board, advisable when using light bronze, so that the draught is reduced in the upper portion of machine; J, Wire mesh to prevent paper or a rough material mixing with the bronze; K, Baffle plate.

The feeding arrangement enables the feeder to keep up a high rate of speed, the sheet being fed in the long way as on the printing machine, thus increasing the capacity of the feeder. The burnishing pads have ample rubbing surface, and are quiet in action and easily removed. In the gearing no chains or belts are used. All wheels are cut with a broad face. The dusting rollers are made of steel, perfectly true, and have a large surface. They run slowly, and with care will last for years. The covers are fastened to the stock by means of a bar, and can

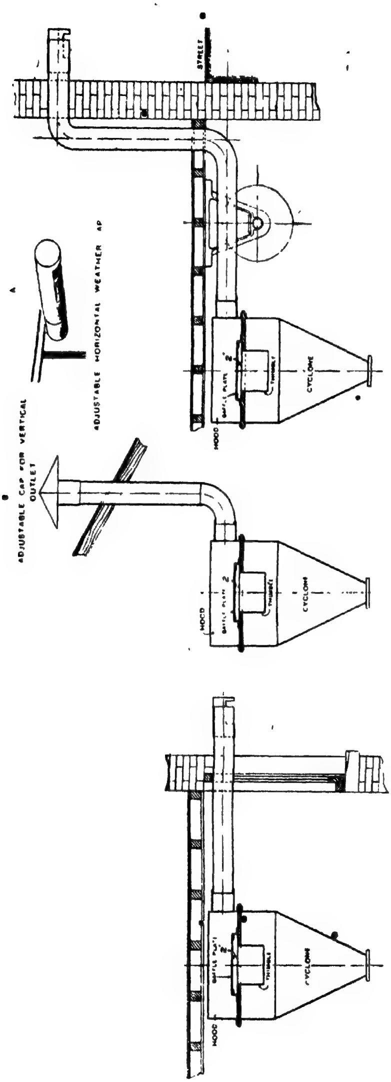


FIG. 98.—Arrangements of Cyclone Outlets.

be removed and re-covered in a few minutes. No glue, laces, or other objectionable devices are used.

A fine spray of bronze is sprinkled on to the sheet from a plush-covered roller. This roller does not touch the sheet, and so cannot become clogged by the ink. The quantity is regulated in the same way as the ink in an ink duct on a printing machine. The sheets are delivered into a flyer similar to that on a printing machine, and are kept straight by a jogger. A straight pile of bronzed sheets is dusted both back and front, at the rate of 1500 to 2000 per hour, with one person feeding. The backs are dusted by a special dusting cylinder, the dust when recovered returning again into the machine.

When metal leaf is used, the leaves are laid one by one all over the sheet, and a glazed hand roller passed over to press the metal into contact with the ink. It is then usual to lay two sheets face to face and to pull them through the hand press under pressure, or to pass them through a paper-rolling machine between metal "paper-glazing" plates, after which the superfluous metal is cleaned off by rubbing the sheet over with a felt pad.

Hints on Bronzing.—As a general rule the bronze is the first printing, but this is not always the case. Sometimes as many as seven to ten workings must be printed before the bronze, in which case very special precautions have to be taken by the printer during the printing of these early colours. The chief points to be observed are in connection with the inks, which must be used so that they will sink into the paper and not dry on the surface. This is effected by (1) using strong colours and printing with the minimum quantity of ink; (2) avoiding driers, medium and strong litho varnishes, and other sticky substances; (3) reducing the inks with the thinnest possible reducing mediums, such as extra thin litho varnish, petroleum oil, vaseline, etc. Yellow chrome inks might also contain in addition a little tallow and a very small quantity of ordinary paraffin oil. The bronze powder itself also requires some consideration. The finer this powder is, the more readily it will adhere to printed work; and while it is sometimes impossible to make headway with a job owing to the bronze adhering where it is not required, by changing it for a coarse quality the work may be proceeded with. If the work cannot be got on with owing to this trouble, it must be first dusted over with a mixture of peasemeal and French chalk well rubbed in to the work. A small quantity of this powder mixed in with the bronze will also help.

The Rotation of the Colours.—The printer must be guided as far as possible by following the original progressive

copies, but it is not always essential that he should carry this out to the letter, and there is an opportunity here for the use of a considerable amount of common sense. When there is no bronze to print as the first working, it is sometimes a good plan to do one of the lightest colours, such as a light grey or buff, first. Either of these colours, if the register should not be perfect, would not appear as bad as a strong colour would, and while either would form a good base for the other colours to print on, the paper will be all the better and flatter for the running through. It will be well after this to get on some of the opaque colours, commencing with the chrome yellows and the vermilion. The last-named colour is sometimes used when scarlet lake containing a little transparent yellow would serve the purpose as well, and could be better printed at a later stage.

Print the Outline Forme Early.—It is a great advantage to print the outline forme at a very early stage. It cannot possibly do the work any harm, and it may do a great deal of good by allowing the most accurately fitting colours to be printed immediately afterwards. This outline forme may consist of a dark brown, or a dark grey, or a black printing.

Double Printing and Double Rolling.—Double printing and double rolling are sometimes resorted to as a means of securing a better result, when a large slab of heavy solid work is required, than can be got by single printing or single rolling. Double rolling means inking the forme twice for each impression taken. Double printing, when possible, will give a flatter and smoother print than double rolling will give, but if there is small lettering running through the solid parts there is a danger of blurring through the register not being dead. Much will depend upon the quality of the paper for this. If double printing has been decided upon, it is better to print the first colour, with single rolling of course, fully half the strength of that required for the final result, and as regular as possible.

A fine rich matt effect may be obtained on a good enamel paper by dusting over the second printing in double printing with cornflour. The cornflour may be used plain, or it may be dyed, in which case it must be afterwards dried and then powdered again before it can be used. The process is very suitable for interior decorations. For most ordinary classes of work, however, the average printer will prefer double rolling to double printing, owing to the risk of inaccurate register with the latter.

The Cause of Setting-off.—"Setting-off" is a term used to indicate that the printed matter on one sheet is parting with a portion of its ink by depositing it on the back of the sheet immediately above through contact. Whether this matters

materially or does not matter will depend entirely upon the nature of the particular work in hand. In any case this ought to be prevented whenever possible, because if the back of the sheet is not important, the work on the front of the sheet is not improved by parts of the ink being picked off or reduced in places.

Setting-off is caused by the paper not being able to absorb the ink before the succeeding sheets are pressed into close contact with the wet ink below, with the result that they must necessarily pick up a certain amount of it. In chromo work, following up the colours in quick succession will cause setting-off owing to the earlier colours not having had a chance to dry sufficiently. On the other hand, if too long a time elapses between the printings, the same thing may happen by the earlier printed colours becoming hard and tinny, and refusing to allow the paper to absorb the later colours.

Prevention of Setting-off.—There is only one reliable method of preventing setting-off, and that is by *interleaving* or *slip-sheeting*. Each sheet, as it is printed, has placed over it a sheet of suitable brown or other roughish paper to separate it from the next sheet. The printed sheets may be laid back to back, so that only half the number of slip sheets will be required. Care must be taken during printing that the ink is not allowed to dry sticking to the sheets. Slip-sheeting is always more or less troublesome, and adds to the cost of production, and it is better if it can be done without. Special trays may be used for the purpose of lessening the risk of setting-off by laying the work out in these in very small quantities. The trays may then be piled up.

Register.—The term *register* means the agreement of two or more formes, that is, the accurate fitting of one printed colour to another to form a perfect design. Without the means of obtaining absolute register, colour work would be impossible.

Some Causes of Inaccurate Register.—The register may be affected by any of the following conditions:—

1. The working parts of the machine may have become worn.
2. The cylinder may not come properly home.
3. The paper may slip between the gripper rests and the gripper plate.
4. A groove may have been cut in the side-lay by long continued cutting of the sheet as it is drawn away from it by the cylinder, the sheet sometimes getting into the groove and at other times lodging outside of it.
5. The gripper plate or fingers may not grip the sheet sufficiently tight, or may grip it only at one end.
6. The stone may not be properly locked up.

7. The paper may be badly cut, the edges being cut concave or convex.

8. Atmospheric influence may affect the paper between the printings.

Improvement of Register.—In the first of the above cases the machine might be improved if overhauled by the makers. In the second case, the push rod must be readjusted so that it pushes the cylinder-stop right home to the stop-block, but care must be taken that this is not overdone. Always test it after making this alteration by turning round the cylinder by hand before putting on the power. The cylinder-stop and the stop-block should not be jammed too tightly but only enough to hold loosely a piece of thin printing paper between them.

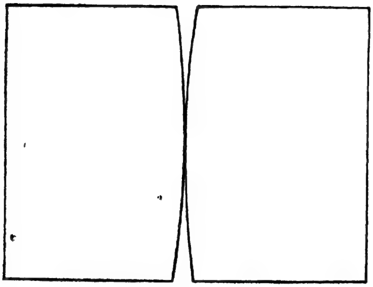
If the defect is due to the third cause, the rest should be slightly sunk into a groove cut in the gripper plate. To remove the fourth of the above causes of bad register the side lay must be taken off and carefully filed until the cutting has been entirely removed, when the face should be finished off by rubbing with fine emery cloth. A small piece of case-hardened steel inserted in this part will prevent cutting of the side lay.

In the event of the gripper being at fault, if it is one of the old-style solid-plate kind, it may be tested by putting in a sheet of paper and then closing it, after which the sheet should be pulled at either end and in the centre. If it is found too loose at any particular part, it is probably due to having got bent, and it may require to be straightened by a mechanic; but it may sometimes be made right by loosening the screws and inserting a small piece of card at a convenient place or places, so that when the screws are tightened again the packing will have the effect of bulging the plate slightly at those particular parts. With finger grippers, a strip of paper should be placed in each and the grippers then closed. The fingers then found to be loose must be re-adjusted.

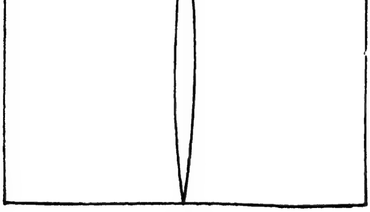
If the stone or bedplate is not locked up properly, it will certainly move and the work will be spoiled. Sometimes a screw becomes loose through the jam nut not having been tightened sufficiently, or owing to its being worn. The blocks, being of wedge-like shape, may have worked loose and thus given the stone play, especially if the pressure has been excessive on the back edge. If the trouble arises from any of these causes, the remedy is obvious.

Badly cut paper is often the cause of variations in the register (Fig. 95). Sometimes it is cut far from square, and when a sheet is pulled up to the side lay the top of the sheet extends beyond this, and in passing the side lay it is gradually forced to take the form of a wave, which may or may not recover itself

before it reaches the printing surface. There is room for improvement on planographic machines in this respect. The side lay should move back the moment the grippers have taken the sheet. If the paper has been cut with a convex edge, that is, cut with a rounded edge like the rockers on a rocking chair, there may be no end of trouble in store if it is not noticed before the first printing is done, and it will be extremely difficult to do much with the work afterwards, as some of the sheets will have rocked in one direction and some in another, whilst others have rocked only part of the way and some not at all. If the paper has been cut the opposite way to this, that is, with a concave or hollow edge, things may not be quite so bad, because in this case it will be impossible for the paper to rock; but if the sheet is a thin one it may give trouble by sagging, especially if in the following printing the sheet does not fall on the rests in exactly the same manner. (See Fig. 99.)



Convex Edges.
Two sheets laid edge to edge.



Concave Edges.
Two sheets laid edge to edge.

FIG. 99.—Badly Cut Paper: Curves Exaggerated.

Prevention, however, is always better than cure, and the test before starting to print is a simple one. Take two sheets from the same place in the ream and lay them down on the floor or bench with the selected gripper edge in an upright position; then take hold of the left-hand bottom corner of the top sheet and turn it right over so that the same two selected edges come together. It will then be readily seen whether the paper has been cut straight, convex, or concave. The correct thing to do in the latter cases is to

have the paper trimmed straight. If this is impossible, then in the event of the paper being convex, take away or lower the rests from the centre of the sheet; and if it is concave, take away or lower those at either end of the sheet.

Atmospheric changes have a considerable effect upon register. In dry, warm weather the tendency of the paper will be to contract, whilst the opposite will be the effect in cold or wet weather. The paper may have been carefully seasoned by hanging, but if a change should take place in the weather while the work is in progress, great difficulty may be experienced in obtaining the best results during the later printings. If the work is piled or stacked and kept covered with wrappers instead of being spread out in trays in reams or half reams and without protection, trouble from this source will be considerably minimised. If it is considered absolutely essential that the work should be spread out in trays or racks, then keep a good supply of slip sheets on top of each lot and let them hang well over the edges of the work.

Unequal Damp and Pressure.—Having noticed the effect that atmospheric moisture has upon the paper, it will be easier now to imagine what the result might be and the difficulties that may arise from an excess of water on the printing forme during the first two or three printings. This excess of water may be all over the forme, or it may be confined to one end only, which if anything is worse than the former. Unequal pressure, especially if the forme is high at one of the back corners, is another cause of bad register, and if the damp happens to be excessive on this end of the sheet, which is usually the case, the expansion of the paper may cause serious trouble.

How to Remedy Expansion of the Paper.—If the expansion has taken place the long way of the sheet, the trouble may sometimes be remedied, or at least minimized, by causing the sheet to bulge out slightly, but not to the extent of causing the paper to crease. The bulging of the sheet has the effect of drawing it in or making it slightly shorter, and this may be done by placing a few narrow strips of paper, one on top of the other (pyramid fashion), down the sloping feed-board; or it may be done by causing the sheet to be pushed out or bulged with a wooden or metal finger fixed to the under side of the feed-board, with the point close to the gripper. Either of these devices must be placed in the position most likely to affect directly that part of the sheet where it is most required. If the stretch has taken place the short way of the sheet, increasing the circumference of the cylinder by putting on an extra outer cylinder cover, or by fixing a sheet of stout paper on to the cylinder by gumming it with dextrine along the gripper edge as recom-

mended for paper-creasing, has very often the desired effect. Reducing the pressure on the back edge of the forme by lowering the stone slightly, and then inserting packing under the front edge to raise it to its proper level again, may also be tried.

Altering a Section.—Sometimes the register may be good all over the sheet except at one corner, which may be very bad, and which no amount of manœuvring will remedy. In this case there are only two things to be done: either transfer the whole job over again, which may produce no better result than the first, or alter the bad corner on the machine. The latter process is carried out as follows. Draw two or more fine-line cross marks at convenient places in the locality where the alterations are to be made, but in positions that will not interfere with the subsequent operations, though they must be within the boundary of the paper. These marks are best made with a brass pin [1] if on stone, or with a HHHHHH lead pencil if on metal plate, for the sake of getting the finest lines. Then clean off the parts to be removed by polishing with Water of Ayr stone, if on stone, or with pumice powder and caustic solution if on metal plate. These substances, of course, must not be allowed to get near the other work, and the cross lines just put in must also be avoided. After washing off all traces of the pumice powder and caustic solution give the parts (stone or plate) a slight etch for temporary purposes and then take an impression on a sheet of the job. Examine the print carefully and see that all the other parts of the sheet have printed in perfect register. If they have not, take another impression, and also see that the cross marks have printed.

If all is found satisfactory, most of the sheet, for the sake of convenience in handling, may be cut off and discarded, but a piece of about 12 in. long in the close proximity of the alterations should be left for a purpose which will be explained immediately. Fresh transfers having now been pulled on transparent transfer paper, they should be placed in position on that part of the sheet which has just been prepared to receive them, and which contains the cross marks, taking care to fix them in exact register. The work on the stone or plate should now be gummed over very sparingly, fanned dry, and then washed out by the asphaltum method, after which the whole surface must be washed with clean water and dried. The parts where the new

[1] If a lithographic stone that has been washed free of gum and dried is marked with a brass pin so as to leave a metallic marking like a weak pencil line, or if a zinc or aluminium plate is marked similarly with a HHHHHH lead pencil, and a thin daub of printing ink applied to the part with the finger, it will be found that upon damping off the superfluous ink with a water sponge the markings have held the ink and will print. The work, of course, has only a superficial hold, but the process is often useful.

work is to be transferred must now be prepared and made sensitive. If the work is on stone the parts should be again lightly polished with the fine Water of Ayr stone, and afterwards sensitized with dilute nitric acid and alum solution. If a plate, the parts must be grained (rubbed with pumice powder and a piece of felt in a manner describing small circles) and then sensitized with dilute acetic or other suitable acid and alum solution. In either case the parts are afterwards washed with plenty of pure, clean water, and both the sensitizing and the washing should be done with a cloth or sponge specially kept for this purpose. It is then fanned dry. If the work is on metal plate, the parts should be again rubbed lightly with fine, crisp pumice powder and then dusted clean with cotton wool.

Now, with a sharp pocket knife, cut out very accurately a corner from each of the cross marks from the piece of the sheet containing the transfers, and then lay the whole face down to the corresponding marks on the dry, prepared surface. Make certain that the position is absolutely right, then place the left hand firmly on the 12-in. piece specially left on for this purpose, and with the right hand lift up the opposite end while some one dampens the parts with pure water, when it is laid down again in a manner that will ensure its falling exactly in the same position. Pass the hand quickly over the back of the sheet to cause the transfers to adhere ; lay a clean sheet over the whole surface, and allow the cylinder to do the transferring, the rollers, of course, being raised during the operation. The parts are then treated as a new transfer.

CHAPTER XXIV.

MACHINE PRINTING FROM METAL PLATES.

Flat-bed Printing.

The Iron Bedplate Supports.—A zinc or aluminium plate being not much thicker than a business card, as against 3 or 4 in. in the case of a lithographic stone, and as a flat-bed machine is not specially built for metal-plate printing only, but also for printing from thick lithographic stones, it is necessary to have a support for the plate in the carriage. The best support for the purpose is what is known as an *iron bed* (Fig. 100). This iron bed compares in thickness and solidity with that of the stone, and it is placed in the stone carriage and locked up in exactly the same manner. There is a gripper arrangement on either side for the purpose of holding the plate in position. On nearly all makes

Fig. 100 —Iron Bed.

of iron beds the front gripper is made in such a manner that it may be drawn forward with the object of tightening the plate after it has been fixed in the grippers. This arrangement, however, does not always prove satisfactory, owing to the impossibility of drawing a plate so tight and close to a flat surface as can be done on a round one such as a cylinder. There is always a certain amount of "play" between the plate and the surface of an iron bed, which means that the plate surface is slightly in excess of that of the support. Now this being the case, when the cylinder comes round with its heavy pressure, everything in excess of the actual size of the iron support must necessarily be squeezed and forced along to the back edge. If at this point the excess cannot, as it were, find immediate escape owing to its be-

ing held tightly in position by the back gripper of the support, it must gradually double up and take the form of a crease. This will not only cause the printing plate to be spoiled for further use, but the cylinder coverings will be cut and spoiled also.

It is now recognized that the better plan is to leave the back gripper just sufficiently loose to allow of the plate "dipping" slightly as the cylinder carries this excess to the back edge. In other words, while the printing plate in the front grippers must be fixed so that it cannot possibly move, the back gripper is tightened in a manner that will allow of the plate being easily moved about in it.

Printing from Metal Plates.—So far as the actual printing is concerned, the fact of the work being on metal plate instead of on stone will make very little difference to the machineman, but glazed forme rollers, of course, are not permissible. These must be either nap rollers or rubber-covered rollers. The work should always be washed out by the asphaltum method on top of a thin film of dry gum, just as recommended for stone, and the inks will require about the same quantity of added grease in the case of aluminium, but on zinc plates grease should be strictly avoided until the work shows signs of requiring it, and then it should be added very cautiously.

Effect of Gum on Metal Plates.—Gum arabic solution is used to such an extent in planography, and is of such great value to the process, that the young lithographer is apt to imagine that the greater the quantity he uses the better must be the results. This, however, is a mistake. Gum, unless it is properly treated with preservatives, such as carbolic acid or formaline, will commence to decompose almost as soon as it is mixed with water, with the consequence that it becomes very sour with acid and is liable to eat through any work that has not been specially protected with resin or French chalk. Gum, as we have already noticed, is the principal desensitizing agent on stone, and in this sour condition it will have no adverse action upon the parts where there is no work, but on a metal plate, under certain conditions, it appears to act differently. In the latter case gum solution is more useful when working in harmony with other "building-up" chemicals, and if it is used thickly on the printing plate at a later stage, that is, after the etching has been completed, it may, if sour, have the effect of eating away this deposited film and exposing the plate to the action of the greasy ink rollers.

An Experiment.—This was proved by an experiment carried out on a zinc plate which had been marked off into four sections, each section being prepared with a different etching solution. The whole plate after etching was washed clean with water and

fanned dry, and the best means then considered for testing the grease-resisting qualities of the four different preparations. Some gum arabic solution (afterwards proved to be sour) was procured from a jar in use at one of the machines, and applied with a clean brush to stop out a portion of each of the four divisions, which was fanned dry. The stopping-out was done with the object of protecting these parts from grease, which was now rubbed in all over the plate. The plate was then dampened with water, which, of course, removed the gum from the parts, and showed them to be perfectly free from the greasy tint which occupied all other parts of the plate. The plate was then rolled up with a black ink roller, and the four preparations showed their good qualities by the plate clearing up and leaving no trace of tint anywhere. So it was again fanned dry and the whole plate subjected to another and more vigorous greasing test, after which it was again inked with the black ink roller. The result this time was exactly as before, except on the parts which, on the previous greasing, were protected with the thick coating of dry, sour gum. These, on this occasion, much to the surprise of all, took grease readily and rolled up almost solid, although they were the very parts which, from the liberal gumming they had received, one would have considered the most grease-proof parts of the plate. It is quite evident then that once a plate has been properly prepared, a thick coating of gum is not only unnecessary, but is likely to prove harmful to both the ink-attracting and ink-repelling parts; therefore in gumming-up use thinnish gum and wipe it down with a cloth until only a trace of it is left, which should be fanned dry at once, making sure that the gum is fresh. A small quantity of the ammonium phosphate solution as recommended for use on the rotary machine should always be kept in the damping water.

Rotary Printing.

The Principles.—The same principles that affect the working of flat-bed machines also hold good on rotary machines, whether they are direct-printing rotary machines or rotary offset machines, only perhaps in a more marked degree on the latter. The machine must be kept scrupulously clean and *very carefully oiled*, and the damping and inking rollers must be kept in a thorough state of repair. Careful attention must also be given to the cylinders to see that they are all as nearly of the same peripheries as it is possible to get them; otherwise they will not work in unison and the result will be a slurring of the work.

Setting the Pressure.—Unlike the flat-bed machine when stones are being used, the pressure does not require to be set

with each different job. The flanges or bearers on either end of the cylinders indicate their full circumference or periphery, and these, under printing conditions, should be almost bearing on each other, but not quite. This, of course, means that to obtain sufficient pressure, the cylinder coverings must be slightly higher than the bearers, which may be tested by placing a long straight-edge right across the impression cylinder and then finding the difference between the straight-edge and the cylinder bearers with a feeler gauge. It is important that the pressure should be uniform at either end. The better way to find this is to take two long strips of the paper or card to be printed, and to put the cylinders into contact, with one of these strips between them at either end, and then to take off pressure until the strips are free and may be pulled out. Now put on pressure until the cylinders again grip the strips so that they can only be moved by moderately strong pulling, allowing the same pull at either end, after which pressure may be added equally until a firm printing impression is obtained. Regarding the amount of pressure necessary, this must be regulated to a certain extent by the nature of the printing paper; but always work with the minimum and bring up the solid parts (if printing from zinc) by judiciously patching the cylinder. Light pressure is best for the work on the plate, best for the paper, and best for the machine.

Register on Rotary Machines.—An occasional cause of bad register in colour work, and one that may be entirely overlooked, or not even dreamed of, is the stretching of the metal plate from which the work is being printed. It is a good thing, when putting on the printing plate, to have it close and tight to the support (cylinder), as we have seen from our experience with the iron bed on the flat-bed machine; but so great is the strain or pull that may be brought to bear on a zinc or aluminium plate by the use of a powerful screw key or tommy key that it is very easy for the work and plate to be stretched considerably without the machineman having the slightest idea that such is taking place. Machine-makers now recognize this and arrange the plate clamps so that the plates are drawn tight by hand only, and without the aid of any mechanical contrivance. It is well to remember then, in putting on a zinc or an aluminium plate, to avoid all tension beyond the simple contact with the cylinder. A little strain may be found useful in the later printing *after* an impression has been taken, when it may be discovered that the paper has expanded slightly either at one end only or all over. But if the strain has been put on in the early stages of the work, and the work is already stretched, the evil has been done and can only be remedied by putting the work on again, set up to a printed sheet instead of the key.

The Automatic Damping Apparatus.—The forme-damping rollers should be set with equal pressure on the printing plate and the brass water-distributing roller. This may be tested by pushing a clean palette knife between them and slowly withdrawing it again in a similar manner to testing the pressure of the cylinders with the strips of paper. The pressure of the dampers should not be great, but just sufficient to give a nice uniform damp without marking the work. The damping trough should be cleaned regularly and supplied with fresh water, and it is a good plan to keep a little of the following solution *always* mixed with it to prevent thickening of the work and tinting of the plate, and also to prevent previously printed colours from repeating on the plate and taking ink. The solution is composed as follows: Dissolve ¾ oz. ammonium phosphate in water, and add this to 1 quart of thin gum arabic solution; use a teacupful (more or less) to a bucket of water.

The brass fountain roller should be kept clean and not allowed to gather grease; otherwise it cannot possibly supply water evenly to the vibrating roller. A good plan to help to prevent this roller from taking greasy ink readily is to clean it thoroughly with benzoline, and afterwards to rub it with plate-etching solution and gum it over. This, of course, must be washed off before using. It is well, however, to allow the brass distributing roller to gather ink to a certain extent, as this helps considerably to keep the dampers clean and in a good absorbent condition.

The Forme-inking Rollers.—The forme-inking rollers should be set with their full weight on the printing plate, allowing just a slight clearance in the brackets; that is to say, the rollers should not be resting in the bottom of the brackets, but just free of this. The geared rider rollers, however, should rest on the bottom of the brackets, and the forme rollers should be carefully set to them, testing the contact at either end with strips of strong paper, just as the cylinders were tested. These remarks apply to both direct-printing and offset-printing rotary machines.

Special Precautions on Offset Machines.—Owing to the resilient and sensitive nature of the rubber blanket on the transfer cylinder, careful setting of the pressure is even more important on offset machines than on direct rotary machines. The contact between the rubber blanket and the printing plate should be such as simply to give a firm impression and no more. Anything beyond this is superfluous and harmful. To demonstrate how light this pressure may be, charge some work with ink and then lay a piece of rubber blanket 1 in. square on some part of it and press it on the back with the thumb. Now lay the rubber on a piece of paper and press it again, when the result will be a perfectly printed offset.

Cylinders True with Each Other.—It is most essential that the periphery of the cylinders should be exactly the same, so that they run dead true with each other. A good method of ascertaining this consists in testing with a ruler and a steel feeler gauge. The bearers on either end of the cylinders are the true peripheries, but of course the blankets and printing plates should be very slightly above them. Place the ruler on the printing plate with one end extended well over the bearer, and find what clearance there is between them by inserting the feelers. Suppose, for example, the clearance is found to be ·05 in. Now test the transfer cylinder (the rubber blanket) in the same manner. This is found to be ·06 in. Now put the cylinders into contact, with a proper printing pressure on, and find the space between the bearers. Suppose this space to be ·10 in. The figures will then read :—

Plate	·05 in.
Blanket	·06 in.
Total	·11 in.
Between the bearers	·10 in.
Difference	·01 in.

This shows a pressure of ·01 in., which if deducted from the blanket (transfer) cylinder total leaves it at ·05 in., which makes the cylinders equal. If there is much difference, it must be made up by either increasing the periphery of the one or decreasing the other ; otherwise the result will be slurring or ribbing.

The Rubber Blanket.—The rubber blanket requires careful treatment. Constant washing tends to make it greasy and sticky. A good plan is to have two blankets, so that they may be used alternately, giving each a week's work while the other rests. There are several preparations on the market for washing these blankets, but ordinary benzoline and solvent naphtha are useful for this purpose. The blanket, however, should always be first wetted over with water before applying the solvent. When the washing has been finished, and the blanket dried, it should be dusted over with fine sulphur powder, French chalk, or magnesia, but the first or a mixture for preference.

Inks for Offset Machines.—Inks for use on offset machines, owing to the thin film of colour picked up by the rubber from the printing plate, should be of strong powerful body when full colours are required. They should be reduced with the thinnest of reducing mediums, such as liquid paraffin (petroleum oil) and pomades. Tints are best made up with tinting white mediums, but they should be made of easy consistency and not tacky.

CHAPTER XXV.

SPECIAL FINISHING AND OTHER PROCESSES.

Varnishing Lithographed Work.—All ordinary work that is to be varnished must be printed upon papers sufficiently hard-sized to resist the penetrating tendency of the varnish. The

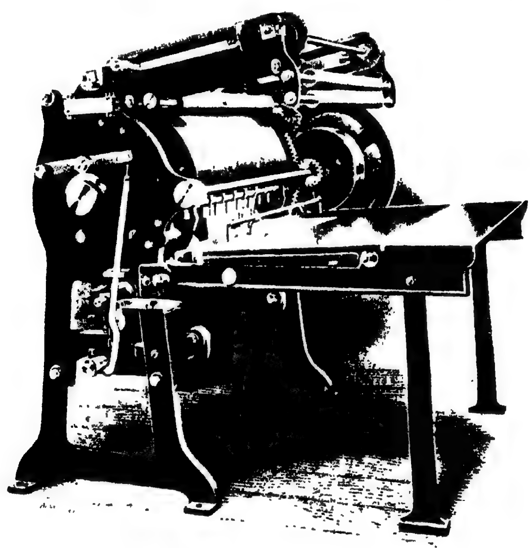


Fig. 101.—"Newsum" Varnishing Machine (Geo. Mann & Co., Ltd.).

varnish generally used for this purpose is shellac varnish, that is, shellac dissolved in spirit. For the better class of work a proportion of copal varnish may be added to this, and for the cheaper classes resin may be added. The work is done on a varnishing machine (Figs. 101, 102), and is then passed on to a travelling

band. If the band is of sufficient length and the temperature kept to suit, the sheets will be dry and may be collected as soon as they arrive at the returning point of the band; otherwise they must be hung over ropes or placed in trays.

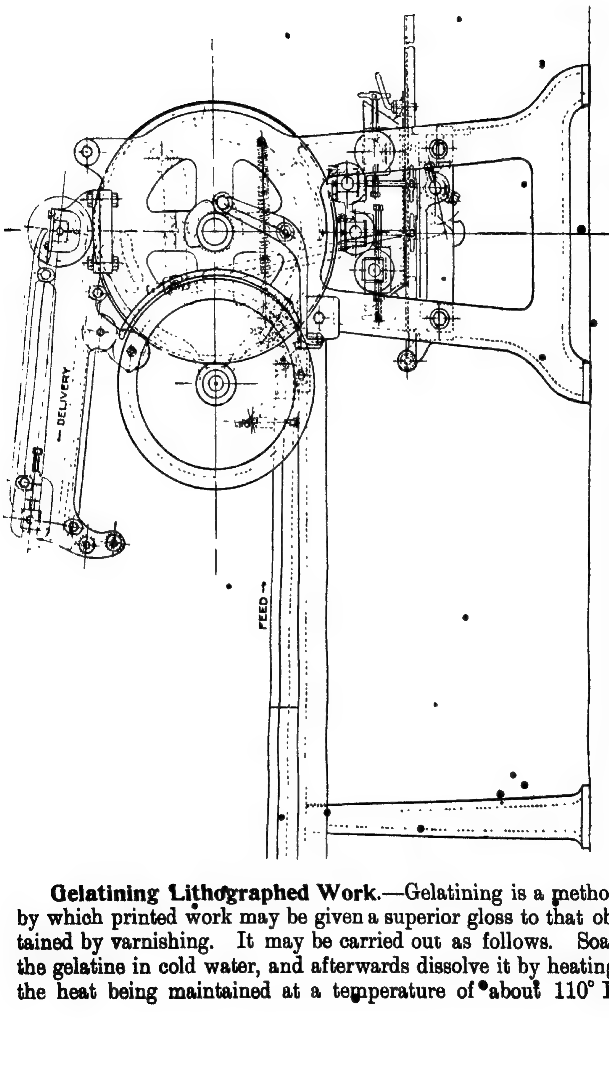


FIG. 102.—"Newsum" Varnishing Machine: Diagrammatic View.

Gelatining Lithographed Work.—Gelatining is a method by which printed work may be given a superior gloss to that obtained by varnishing. It may be carried out as follows. Soak the gelatine in cold water, and afterwards dissolve it by heating, the heat being maintained at a temperature of about 110° F.

A sheet of clean glass which has been previously well rubbed over with French chalk is dipped into the melted solution so that both sides take on a coating. The glass is then stood in a rack until the solution has set somewhat, when a print, which has been previously soaked in water, is laid (face to the gelatine) on either side and fixed by rubbing with a roller squeegee. The prints must then be left until thoroughly dry.

Finishing Chromo Work.—There are several methods of enhancing the decorative effects of otherwise finished chromo-lithographed work. These include *Roughing*, *Graining*, *Embossing*, decorating with *Spangle* or *Glitter*, *Frost and Snow Powders*, *Iris Powder*, and *Flock Powder*.

Roughing Printed Work.—Roughing is a method of producing an irregular granular effect all over the sheet, and giving to it the appearance of having been printed upon a hand-made drawing paper. The effect is produced by passing the sheet through a flat-bed machine under a good pressure on top of the roughened stone. To make the rough stone, first select a stone of fairly hard quality and see that it is perfectly level. Have it grained with coarse sand or glass powder exactly as described on p. 14. It should then be washed clean with water and a hard brush and allowed to dry. The whole surface is then rolled over uniformly with a glazed hand roller sufficiently charged with transfer ink to protect each little point or grain properly, after which it may be dusted with resin and then with French chalk, and the surface subjected to a mild etching with dilute nitric-gum solution. The grain is now treated as an ordinary transfer, repeating the inking and etching until a grain has been secured of sufficient depth to produce the desired effect upon the work, when all ink is cleaned off. It is generally better to work with the damping rollers in the usual way while roughing the paper, as the damp prevents the printed matter from being picked off by the rough stone.

Graining Printed Work.—Graining is a method of producing upon the sheet a slightly embossed effect similar to roughing, but of more regular texture. This usually takes the form of stipple dotting, line work, canvas or open muslin patterns, etc. Transfers of the first two may be taken from engraved copper plates or shading mediums, but for the last a piece of fine canvas, muslin, or bookbinder's cover cloth should be selected. A stone slightly larger than the piece of selected cloth should be set in the press and then inked over solid with a sparingly charged transfer ink roller. The piece of cloth is then laid on top of the ink and pulled through under pressure. If the cloth is now laid upon a clean stone and pulled through (once only) under a fair pressure, a complete pattern of the cloth in transfer ink will be the

result. This is now prepared in the usual way, and a sufficient number of transfers are taken to fill up the size of sheet required. The work is then transferred and prepared by etching until the required relief has been obtained, which should be fully thicker than a business card. Sometimes a better result is obtained by first transposing the original design. The best impression is obtained by using an india-rubber blanket on the machine cylinder. Special graining machines may also be had for this purpose, consisting of engraved metal rollers between which the sheets are passed. The results are very satisfactory.

Embossing.—Embossing, or producing high relief from a lithographic stone, is carried out in the following manner. A key offset is made upon a thickish stone, and the parts are engraved as required. A light tint may be printed at the same time as the embossing is done, if so desired. If the relief to be obtained is not considerable, a few sheets of paper such as stereotypers use may be brushed over with paste, mounted on the cylinder, and run through under pressure while the paper is still moist. This will form a kind of die, which must be allowed to become thoroughly dry and hard before proceeding with the work. If the relief is required to stand out considerably, and the engraving has been deeply cut, the engraved parts should be wetted and a piece of very thin paper laid over them and forced to the bottom with a tuft of cotton wool. The hollows are then filled in with plaster of Paris, into which has been mixed a little glue. After the plaster has set, touch over the top of each part with fish glue or other strong adhesive, and then pass round the cylinder slowly. The plaster castings will then come round adhering to the cylinder, which must be allowed to harden before the work can be proceeded with.

Spangle and Kindred Work.—Spangle and similar substances are composed chiefly of metal, glass, and fibrous materials, and are used for the purpose of adding to the general richness of a design, especially on Christmas cards, post cards, birthday cards, and such like. *Spangle, glitter, or flitter*, as it is sometimes called, is chiefly made from thinly rolled copper or brass, broken up into small particles. They are dyed to all shades of colour and give a pretty glittering effect. *Iris* is the same thing, but takes the form of small granules, and makes a good imitation of jewels. *Frost and snow powders* are generally made from glass. The method of attaching these powders to the work is practically the same in all cases. The parts are gone over with a brush or tubular pencil containing a strong adhesive, such as fish glue, and the print is then passed through a quantity of the powder in a manner that will cause the particles to adhere to and embed themselves in the glue.

Graduated Tint Printing.—A graduated tint is sometimes printed as an ordinary colour of a show card, a show bill, a calendar, etc., that is to say, a solid tint is drawn direct or transferred to the printing surface so as to print on a given space on the sheet. Or the tint may be printed over the entire sheet from edge to edge of the paper, in which case a clean, dry, polished stone is all that is necessary, no transferring requiring to be done, but the damping rollers must be raised or removed, and the work printed without them. The ink should be mixed to suit the strongest colour, which generally comes at the top of the work, the tint gradually tapering off towards the bottom. Sometimes, however, the strong colour comes in the centre, and the tapering off is extended in either direction. It is better to make three or four strengths of colour by reducing the strong ink with more and more varnish and tinting medium, and then dividing it in the ink duct by thin lead castings. It is an advantage to have both the forme rollers and the distributing rollers made to oscillate.

Rainbow Printing.—Rainbow printing is done in exactly the same manner, and is just another form of graduated tint printing, using for the purpose a dry stone or plate. The three inks, blue, crimson lake, and yellow, are divided off in the ink duct with the lead castings and the colours made to run into each other, or blend, by the oscillating of the rollers. In hand press work the colours should be arranged in order at the top of the slab. After each print the roller is pushed up to the colours in a manner that will allow of the roller picking up just the proper amount each time. The variations in laying the roller on the slab while distributing the ink will be quite sufficient to cause the colours to blend nicely.

Printing Transparencies.—Transparencies are transparent printed designs for decorating the windows of dwelling houses in imitation of stained glass, or for advertisements to fix on to windows of tram cars, omnibuses, railway trains, etc. These are sometimes specially printed to be viewed by transmitted light, as from the inside of a bus, in which case all colours used should be as transparent as possible, but sometimes they are printed to be seen from the street, in which case they are viewed by reflected light. In the latter case parts of the work are required to remain white, and a special opaque white must be printed to give the effect. If any colour is required to stand out from the others with exceptional brilliancy, such as a strong, telling red, this colour must be printed in accurate register upon both sides of the paper. This is done by the simple process of first printing direct on to the cylinder blanket, which should be a rubber one, and then printing the next impression on the sheet

in the usual way, thus securing a direct print on one side of the paper and a transferred impression from the rubber blanket in absolute register on the other side. The paper for this class of work must be thin, strong, and well-calendered, and must absorb varnish readily. The sheets are afterwards varnished either on one side only or on both sides, which converts them from the opaque to the transparent. They are then coated on the face with a strong adhesive composed of gelatine and gum applied warm. By simply damping a print with a little water it may be fixed on to any piece of glass or window.

CHAPTER XXVI.

DIRECT PHOTO-LITHOGRAPHY IN LINE AND HALF-TONE.

Direct Photo-lithography.—Direct photo-lithography is so called because the design is printed direct on to a lithographic stone, or on to a zinc or aluminium plate (the plate being preferable owing to the difficulty of obtaining sufficiently close contact on

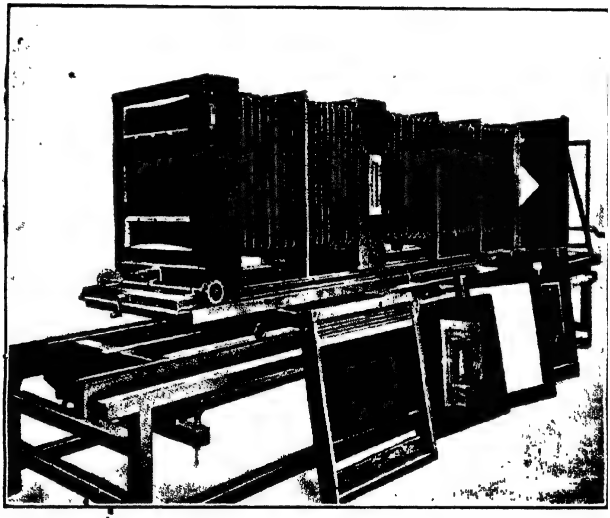


FIG. 103.—Camera for Photo-lithography.

a cumbersome uneven stone), instead of being done on photo-litho transfer paper and afterwards transferred to the printing surface. This is a much more satisfactory method than the latter, and it also saves time and risk in transferring. The negative for this purpose should be exactly as that required for a photo-litho transfer on paper, but in this case it must be made to read the

opposite way. Such a negative is called a *reversed negative*, and is obtained by using a reversing prism (Fig. 104) in the camera (Fig. 103). The stone, or the zinc or aluminium plate, must be coated in a dark room with a film of bichromatized light-sensitive albumen or gelatine, and then dried under the same conditions. It is then exposed under a negative to the action of light, and the design is developed as described in connection with photo-litho transfers on p. 64.

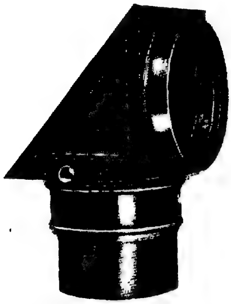


FIG. 104.—Reversing Prism.

The Line Process.—If the copy is a line drawing, or a black impression of one of the colours of a chromo job that has already been lithographed, and from which a reduction or an enlargement is required, the process is known as the *line process*.

The Half-tone Process.—What is generally classed as half-tone work consists of pictures or photographs that have been broken up into small dots or lines separated by white spaces. This is obtained by using a glass plate covered with a very fine network of lines, which is placed in the camera immediately in front of the light-sensitive plate before the object is photographed, and which finally allows of the work being printed by (1) letterpress (relief), (2) planographic (surface), or (3) intaglio (sunk) printing machines.

Half-tone Lithography.—There are several methods of producing half-tone work by lithography, the best of them being patented processes. The "Sears" high-light process, the "Frey" process, and the "Stagmatype" process are examples. It is not essential that half-tone lithography should be based upon the regular cross lines or dots, as some of the finest and most artistic results are obtained by irregular or granular effects, as in the "Frey" process. These effects may be got by first securing a grain on the negative, which is done by photographing the object through an irregularly dotted screen, or by photographically printing the image on to a substance, such as bichromatized gelatine, which, under certain conditions, may be made to give a variety of irregular grains. A transfer suitable for transferring to a planographic surface may then be taken from this by the collotype methods; or the gelatine, supported on a zinc or copper base, may be etched through into the metal, forming an intaglio plate, as in the "Stagmatype" process, and afterwards printed lithographically on an offset machine.

Ordinary Three-colour Work.—Ordinary three-colour plates to be printed lithographically may be made on litho zinc or aluminium from any wash drawing or painting or object by photographing the subject through a half-tone screen, but the screen should not be finer than 100 to 125 lines to an inch. While fairly good results may be obtained by this method, it is quite impossible to produce anything like a first-class job unless "fine etching" is resorted to, a process adopted by half-tone block makers to obtain fine open results in the high lights. Ordinary three-colour work is essentially a letterpress process, and the best results cannot be obtained by any method of transferring the work to a planographic surface, but nevertheless much may be done by utilizing a half-tone photo-litho plate for some of the lighter colours in chromo work.

CHAPTER XXVII.

LITHO PRINTING ON FABRICS AND TINPLATE: DECALCOMANIE TRANSFERS.

The Older Process for Silk and Calico.—For many years designs have been lithographed upon silk and calico. These usually took the form of handkerchiefs, cushion covers, coats of arms, etc., and were printed in small pieces previously

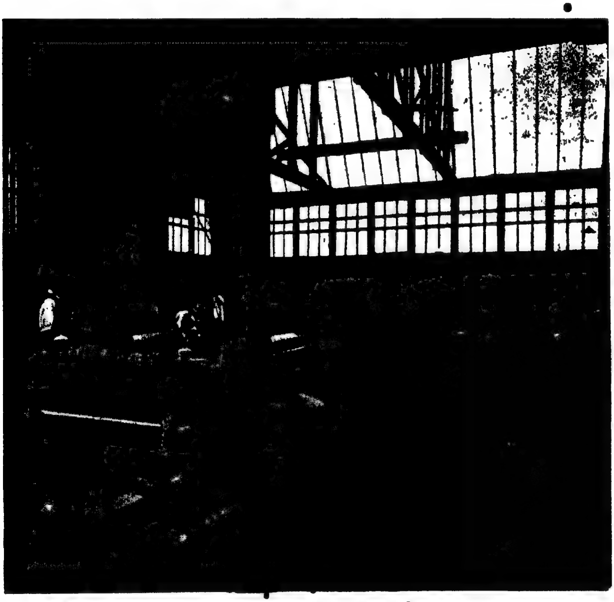


FIG. 105.—Calico-printing by Planography: The Transferring Room.

mounted on sheets of stout paper. In some instances, when the material was fairly rigid from being well-sized, it was possible to print it without previous mounting, but this material was usually of the cheaper quality, and the printing would be lost after washing.

The New Method.—A new method has recently been invented by which textiles may be lithographed from the reel just as newspapers are printed, four or more colours being printed simultaneously by the rotary principle, at a speed of 60 yards and more in a minute. This process promises to revolutionize the calico-printing industry. The designs are usually lithographically drawn on key plates, which are stored and kept till required, when they are transferred by a simple new machine to tubes of prepared zinc or aluminium. After

FIG. 106.—Calico-printing by Planography: The Machine Room.

printing, the designs are cleaned off by ordinary simple planographic methods. When repeat orders are wanted, the work is re-transferred from the original key plates to the metal tubes, which are easily slipped on and off the impression cylinders. Paper may also be printed from this machine just in the same manner as the cotton or silk material is printed, in which case it may be cut simultaneously into any size of sheet by an automatic cutting arrangement. In future wall papers are likely to be printed by this machine as well as coloured newspapers and coloured magazines.

The Older Process of Tinplate Printing.—The application of lithography to the decoration of tin (tinned steel) goods is now a very important branch of the industry, and is extensively carried on in all printing centres. The work is chiefly done by firms who specialize in the manufacture of fancy tin boxes, canisters, advertising tablets, etc., and one cannot have failed to notice the great advance recently made in this direction. Boxes representing bookcases filled with books by well-known authors; vases carrying most elegant and artistic designs in bright or subdued colours, intermingled with gold, silver, or bronze; or tins with the plain, bold, business announcement of "So and

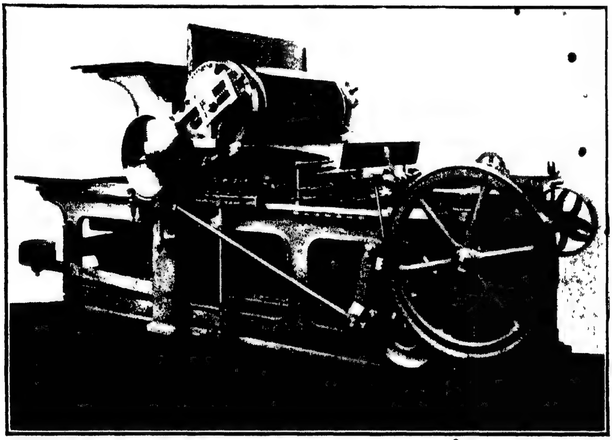


FIG. 107.—Furnival & Co's Tinplate Printing Machine.

So's Brand of Golden Syrup"—all are most carefully got up and beautifully printed.

This work was not at first done by a direct process, but was printed upon a transfer paper coated with a composition of starch, gum, glue, etc., very similar to many of the papers used for lithographic transfers (stone-to-stone). The order of printing the colours upon these transfer papers is exactly the reverse of ordinary printing. If the work is to appear on the box or can in four colours, say yellow, black, red, and blue, the blue would be printed first, then the red, followed by the black and the yellow (or gold colour). On the top of all there would be printed (twice at least) a very opaque white, except upon those parts which are to appear as gold, or a colour showing a metallic

sheen or lustre. A tinned sheet is then coated with varnish, and when it is nearly dry (tacky) the transfer is fixed to it face down and pressure applied in a firm, even manner. When the varnish has thoroughly dried, the transfer is soaked off with water; the design will then appear upon the tin the proper way, resting upon a white ground: and the parts printed in the transparent yellow lacquer, but not covered over with the white printing, will appear as gold, due to the metallic lustre of the tin shining through it. After the whole receives a coat of varnish it is stoved at a temperature of about 135° to 145° F. In printing these transfers it will be necessary to keep the bright colours and the tints strong, as they lose considerably during the

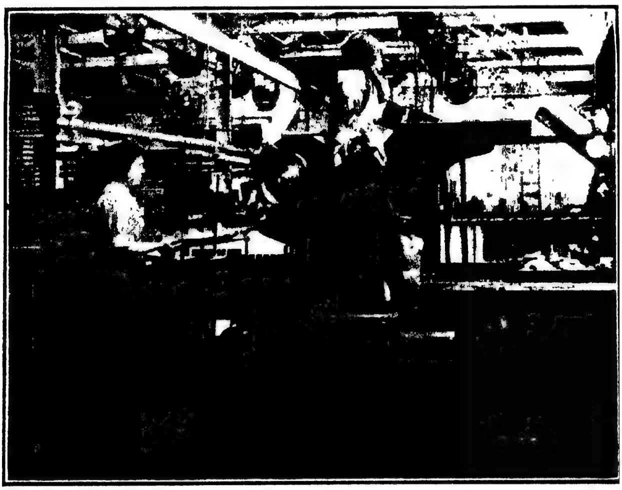


FIG. 108.—Tinplate Printing Machine at Work.

stoving; and driers must be added to all medium or slow-drying inks, as the coating on the paper prevents any absorption.

Direct Tinplate Printing.—The more modern or so-called "direct" method of printing upon tinned plates is an application of offset printing. The printing machines may belong to either the flat-bed or the rotary type, but they are built for this special class of work, and have their own characteristics (Figs. 107, 108). The tinned plate does not come into contact with the printing surface; but, as it is carried round with the cylinder into which it is fed, it receives an offset impression from a rubber blanket

fixed upon a second cylinder, which has already taken a direct print from the printing surface. As the plates are printed, they are placed separately in racks, which, when full, may be wheeled aside to dry naturally; or they may be put into a stove for forced drying.

Before printing, each plate should be thoroughly rubbed on both sides with a duster to remove dirt, grease, etc., which may perchance have got upon it, and which, if left, would prevent the ink from printing or drying properly on such parts. Defective plates must also be removed, and turned-up corners flattened with a mallet. Rough edges must also be smoothed, as otherwise the rubber blanket would soon be damaged.

The colour sequence for this method is exactly the opposite of that in the transfer method; that is, it would be printed like ordinary work done on paper. The white (once or twice printed) would be done first, and would cover up all parts except those

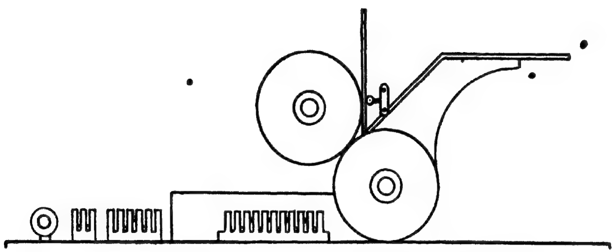


FIG. 109.—Feeding Arrangement on Tinplate Machine.

required to appear as gold and silver, or any parts in which a colour is required to appear with a sheen or lustre. Of course, only transparent colours, such as lakes and blues, would produce this effect. No printing at all is required for the silver, as the metal itself gives this. The transparent yellow lacquer is usually printed after the white; it produces a nice strong buff where it falls upon the white, and a bright gold where it comes upon the bare tin. It may, however, be had of various shades to suit special requirements. It helps to give depth of colour and brilliancy to solid reds and other colours when it and the white are put under them; but if put under the blues the tendency is to cause them to appear blacker. Indeed it is an important matter for the artist when drawing the design to take full advantage of the light colours, as by carefully superimposing the printings the intensity of the colours may be greatly improved, thus giving sparkle and life to the finished work. The black printing would come next, followed by the red and the blue. After

the work has dried, the plates are varnished by machinery and then stoved, after which they are ready for the tin box workers.

As with ordinary offset printing, the rubber blanket will require to be washed several times during the day. This should be done with a very volatile fluid, such as solvent naphtha, spirits of turpentine, or benzoline, and it should be immediately afterwards dusted over with fine flour sulphur. This treatment will impart to the rubber a fine printing surface.

All designs to be printed on tin should be specially lithographed by an artist with experience of tinplate work. Type matter must be reversed; and in photo-litho transfer work the photographer should be given instructions to make reverse transfers; or if it is photographed direct to stone or plate it must be made to read the right way (left to right).

Decalcomanie Transfer Printing.—Decalcomanie transfer work is simply an extension of the tinplate transfer-printing process, so as to make it applicable to almost everything and anything. Unlike tinplate transfer work, special printings must be made when gold or silver enters into the design, for which purpose gold leaf and aluminium leaf are generally employed. The work is also very often of a highly artistic order, and may run into a considerable number of workings. The character of the designs, however, varies a good deal according to the specific purpose for which they are intended. For railway carriages, engines, motor-cars, private conveyances, etc., coats of arms, monograms, and such devices, made bright with crimson, purple, and gold, are usually employed, whilst for sewing machines, bicycles, organs, pianos, and the like, the designs are chiefly confined to trade marks and makers' imprints. For glassware, pottery, and ornamental goods of all descriptions, the designs are often very elaborate and most carefully reproduced.

When the transfers are required for the inside of transparent articles, the colour sequence would be exactly as in ordinary chromo work; but if wanted for opaque goods, the order must be reversed. Quick, hard-drying inks should be preferred. Medium and slow-drying colours must have driers added to them. The sheets require to be interleaved throughout with rough, brown slip-sheets, to prevent the solids from becoming marked by offsetting.

When printing gold or aluminium leaf on reversed transfer work, which, of course, must be the last working, except when a white is employed, a strong transparent medium consisting of lithographic and copal varnishes, Japan gold size, and Venice turpentine must be used to ink in the forme in place of the regular printing ink; but if the transfers are to be printed in the ordinary way, the gold or silver printing would be done first,

using the ordinary burnt umber and yellow, with medium varnish and terebene as the printing medium. Great care must be taken to keep the varnish from tinting the stone, as it is very difficult to detect it; and it would be likely to spoil the work by causing the leaf to adhere in places where it is not required.

Decalcomanie transfer paper is nowadays mostly bought direct from the manufacturer, or through the lithographic supply house; but it may be made by coating a medium-sized printing paper of fair body with a composition made from starch, glue, gum, zinc white, and chalk in varying proportions, with the addition of a little syrup or glycerine sufficient to prevent the paper from curling or cracking. The principle to work upon in coating these papers is to produce a composition upon them that will print well without absorbing the colour; and that will transfer well without being too sensitive to damp during the printing.

The printing is done, as a rule, from stone on a flat-bed machine. The drawback to the use of the metal plate for this purpose is the difficulty of damping the plate enough without damaging the damp-sensitive transfer paper.

CHAPTER XXVIII.

COLLOTYPE PRINTING.

Nature of the Process.—Collotype printing is generally considered to be a planographic process, but strictly speaking it is slightly intaglio. Like lithography, it is based upon the principle of two opposing forces, one that will oppose printing ink and attract moisture, and another that will oppose moisture and attract printing ink. The process is after the nature of photo-lithography, and indeed it is said to have been discovered while

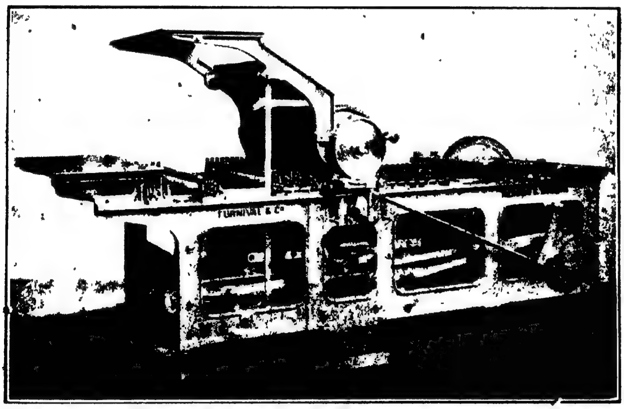


FIG. 110.—Collotype Machine.

experimenting in that direction. Beautiful results may be got from a good plate, the work being photographically correct and possessing a depth in the shadows almost equal to that given by an engraved steel plate, while the finest work is so delicate that no other printing process can compare with it. The method of preparation and printing is somewhat slow and uncertain, and in recent years the process has received a considerable set-back from the less elegant but more certain photo-mechanical half-tone printing process. The work may be printed in a single

colour as a mechanically printed photograph, or it may be done in several colours as in chromo-lithography, and very beautiful results may be obtained on decalcomanie transfer paper for use in pottery decoration.

The Negative.—The negative for this purpose must be a reversed one as described on page 259. The reversing may be done by a reversing prism when the object is being photographed, which is called "direct" reversing, or the film may be stripped from an ordinary negative by first flooding it with a solution of warm gelatine and then allowing it to dry. If the edges of the gelatine are now carefully trimmed with a sharp knife and the blade then inserted under one corner, the whole film may be easily removed. It is then used as the negative. The quality of a negative for this purpose should be soft and full of detail; otherwise the best results cannot be obtained. All parts which are not to be printed are stopped out by first squaring off the work to the size required and then covering up the edges with tin foil or black paper, or painting out the parts with an opaque paint.

Preparing the Printing Plate.—The collotype printing plate consists of a sheet of thick plate glass which is used as a base, with a film of gelatine on top as the printing surface. The glass is specially ground with emery powder until a good, even matt effect has been obtained, which is done for the purpose of giving the warm gelatine solution a grip. When the graining is finished, the plate is put into the warm drying oven for a time, and then coated with the gelatine solution. The gelatine coating is applied twice, the first application being treated with chemicals such as silicate of soda or silicate of potash and chrome alum, with the addition sometimes of a small quantity of caustic potash. This preparation takes a firm hold of the ground glass and makes a good, tough foundation for the real printing surface (the bichromatized gelatine) which is put on top. It also prevents any risk of the machine inking rollers pulling the whole away from the glass base. This second coating, as already indicated, consists of warm gelatine solution containing a proportion of bichromate of potash, chrome alum, and other chemicals which are subject to variations according to usage and the experience of the operator. The weather conditions and the quality of the materials must also be taken into consideration at this stage, and it is sometimes an advantage to use a little ammonia. The plate is flooded evenly with the solution, and it is then placed in the special drying oven through which a free current of air is constantly passing. The time required for this purpose is from two to three hours, the gelatine becoming harder the longer it is kept in the oven, but the temperature should never exceed 130° F.

Printing the Image.—When the plate is cold, it is placed face down on top of the negative in a special printing frame which is fastened down tight to bring the two—the plate and the negative—into very close contact, and is then exposed to the action of light. The time required for exposure will depend entirely upon the quality of both the negative and the light, a dense negative and a weak light requiring much longer than a thin negative and a strong light. Either daylight or the powerful light from an electric arc lamp may be used for the purpose. The usual time for exposure is from half an hour to one hour.

Washing and Preparing the Plate.—When the plate has been sufficiently exposed to the action of light, it is taken out of the printing frame and placed in a bath of cold running water for the purpose of extracting the chemicals from the parts where the light has not acted. As the chemicals wash out, the gelatine absorbs water, which causes it to swell, but the parts that have been acted upon by light, which in reality constitute the work, do not absorb water and so remain sunk, or intaglio, the depth varying according to the nature of the work. The shadows are deeper than the high lights. The deep parts are known to the printer as the *relief* because, presumably, of the contrast they give on the print.

Printing.—When the plate has been thoroughly dried, it is prepared for printing by first soaking it with a solution of glycerine and ammonia. The gelatine retains this moisture for a considerable time, thus allowing of the plate being inked at each impression and a considerable number of prints being taken before it requires to be treated again. The lithographic surface on the other hand, being non-absorbent, requires to be dampened after each impression. Both nap inking rollers and composition inking rollers are used together for printing in the collotype machine. The nap rollers, with their soft granular texture, dip into the little hollows or sunk parts which contain the work and deposit a full complement of ink, and the composition rollers, which follow the nap rollers and are therefore the last in passing over the plate, clear up the work and give softness and quality to the printing. Very stiff ink containing only the minimum quantity of varnish must be used for printing collotype work.

CHAPTER XXIX.

COPPERPLATE OR INTAGLIO PRINTING.

Intaglio Printing.—Intaglio printing is the reverse of relief printing. In all relief processes, including half-tone, the matter to be printed is raised more or less above the non-printing parts of the block or forme, and only these raised parts receive ink from the inking rollers. In intaglio processes, on the contrary, the work is cut into a surface of copper or other material, and after the whole surface has been inked all but the incised parts is wiped clean. Lithography, as we have seen, is intermediate in character between relief and intaglio work, the separation between the work and the non-printing surface being obtained by chemical means instead of by difference of level. Lithography is, however, closely associated in practice with intaglio work, and therefore some account of the latter will rightly find a place in this book.

Intaglio processes are capable of giving greater variety of tone and consequently a softer and richer quality of work than relief printing, because the depth of the incisions in the copper plate, and therefore the body of ink in them, is delicately proportioned to the degree of light or shade in the subject. Even the finest half-tone illustration is inferior in artistic effect to the work done on a commercial photogravure machine, and the latter has the great advantage of not requiring a shiny, coated paper.

Intaglio Processes.—Leaving aside for the moment the various photo-mechanical intaglio processes, we may enumerate the chief artistic intaglio processes as follows:—

1. Line Engraving.
2. Etching.
3. Dry Point.
4. Mezzotint.
5. Aquatint.
6. The Crayon Method.
7. Stippling.

The first three of these are line processes, and the rest are adapted for reproducing tones.

Line Engraving.—Line engraving, dating from not later than the fifteenth century, is the oldest and simplest of the in-

taglio processes. As with the other processes, the material almost invariably used is a copper plate, well-hammered, planed, and polished, but other metals, such as steel and zinc, have been used. The plate is coated with varnish, and the design is then drawn on it reversed (so as to print the right way) or transferred to it. A drawing may be transferred by being placed between damp sheets of paper for a time, then put face downwards on the varnished plate and pulled through a press. In the absence of a press, other methods of transferring may be adopted. A tracing of the drawing may be laid on the plate over blacklead transfer paper and gone over with a blunt point. Otherwise, a

Fig. 111.—Burin.

sheet of gelatine may be laid over the drawing, which may be traced on it by scratching with a needle. The lines should then be filled up with blacklead dust, the gelatine sheet placed face downwards on the copper plate, and the back rubbed over with a paper knife.

Having obtained the reversed outline of the design on the varnished plate, the engraver must now cut the lines into the copper with a tool known as a *burin* or *graver* (Fig. 111). The heavier the line, the deeper he must cut, and great artistic skill and judgment are required. The rough edges are removed with another tool called a *scraper* (Fig. 112), and after scraping, the

Fig. 112.—Scraper.

original polish must be restored with a burnisher and an oiled piece of canvas. Some shading detail can be added direct on to the plate, and texture can be shown by cross hatching.

To print such an engraved plate, it must be inked all over with a special ink, by means of a dabber, and the ink must then be very carefully wiped off the uncut parts with a rag and the palm of the hand. The plate is then put into the copperplate press, with the paper over it, and some soft waste paper or woollen cloth is placed over the whole to even the pressure. It is then pulled through the press under considerable pressure, and is inked again for each impression.

The use of steel plates was very common in the second quarter of last century. They were capable of producing a larger number of impressions without wearing down than copper plates, but the effect is harsher. Steel-faced copper plates retain the advantages of copper while possessing something of the durability of steel.

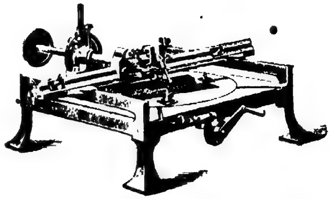


FIG. 113.—Copper and Steel Engraving Machine.

Etching.—In etching, which dates from the early sixteenth century, a chemical action is employed to do the work of the burin in fixing the design into the copper. The plate is covered with an acid resist called a *ground*, consisting of a mixture of white wax, gum mastic, and asphaltum. A ball of this mixture is enclosed in a piece of thin silk and passed over a hot plate so that the ground melts and comes through the silk. It can then be dabbed on to the plate. Otherwise, the ground may be made into a paste with oil of lavender and spread on the plate with a roller, the oil being afterwards evaporated off by gentle heating. Whichever method of applying the ground is adopted, it must be blackened by smoking it over a lighted taper, in order that the etcher may be able to see his work on it.

The etcher works with a needle set in a wooden handle (Fig. 114), removing the ground along the lines of the design but not

FIG. 114.—Etching Point.

scratching the copper. The back and edges of the plate are then covered with a protecting varnish, and the exposed parts of the copper are subjected to the action of a bath of mordant. The usual mordant is diluted nitric acid, but nitrous acid is sometimes used, and also a mixture of chlorate of potash and hydrochloric acid, called *Dutch mordant*. Perchloride of iron is the mordant used in preparing process plates. The bubbles must be removed with a soft brush as they appear, and their appearance serves as a guide to the time required for properly biting the design into the copper. There are no bubbles with the Dutch mordant. After the biting is judged complete, the plate is taken out of the bath, rinsed with water, and dried, and the ground is removed with a rag and turpentine.

The printing is done as in line engraving, but is more difficult and requires greater skill in the wiping of the ink. Delicate effects can be produced by not wiping uniformly clean.

Black grounds have been used in order to obviate the necessity of smoking; and a liquid ground, consisting of the ordinary ground dissolved in chloroform, has also been tried. The chloroform can be easily evaporated off. The etcher works under the disadvantage of having the light unetched parts dark, giving a negative effect, and therefore attempts have been made in the direction of positive etching. A silver-coated plate with a ground of specially prepared whitening has been used.

The process of *stopping-out* is important and requires some explanation. When some of the lighter lines of the design have been sufficiently bitten by the mordant they may be covered over with Brunswick black or some other protecting varnish, and the plate then exposed to further biting in the stronger lines. Several successive stoppings-out may take place in this way, so as to produce the required gradations of line. Another method of achieving the same result is to draw in at first only the heaviest lines, then to add the next heaviest after the first have been exposed for a time to the mordant, and so on, the finest lines being marked out by the needle last of all

Dry-point Engraving.—In dry-point work the design is scratched direct on the copper with an etching needle or diamond point. The scratching raises a ridge or *burr* on one side of the groove or on both sides, according to the inclination of the needle. This burr is not removed, and the clinging of the ink to it in printing gives a rich, soft effect. It is a difficult method for the artist and for the printer. The burr soon wears down in printing, and the characteristic quality of the dry-point print then disappears. The number of good copies that can be obtained from a plate is not more than twenty at the outside, unless steel facing is resorted to. The process is used chiefly for landscape and portrait work.

Mezzotint Engraving.—Unlike the previous processes, mezzotint is a tone method of engraving. It was invented in the seventeenth century by a German called Ludwig von Siegen, and was also practised by his contemporary Prince Rupert, the famous cavalry leader in the English Civil War. For mezzotint work the copper plate has to undergo the laborious preparatory process of *rocking.* This is effected by a tool called a *rocker* (Fig. 115), a kind of steel chisel whose edge is set with very minute teeth. The engraver works down the left-hand side of the plate from the top edge with the tool in a zigzag manner, and continues in this way strip by strip across to the right-hand side, until all the plate has been covered. He then goes over the plate again in a direction at right angles to this one, and sub-

sequently in various slanting directions. The result is to produce a surface that is, as it were, burred all over in a very fine way.

The next step is to draw the design on the rocked plate or to transfer it in one of the ways previously indicated. The engraver next takes a lancet-like scraper and cuts away the rough grain of the surface in the lights of the design, more or less according to the strength of light. In entirely white parts that are to carry no ink, the plate must be repolished. If any part is over-smooth, it can be re-rocked to a greater or less extent. Apart from the laborious preparation of the plate, the process is an easy and expeditious one. Mezzotint engravings have a dark character as compared with engravings by other processes.

Aquatint Engraving.—Even more recent in origin than mezzotint is the aquatint process, which is a kind of tone etching. It was invented by a Frenchman, Jean Baptiste Le Prince, in

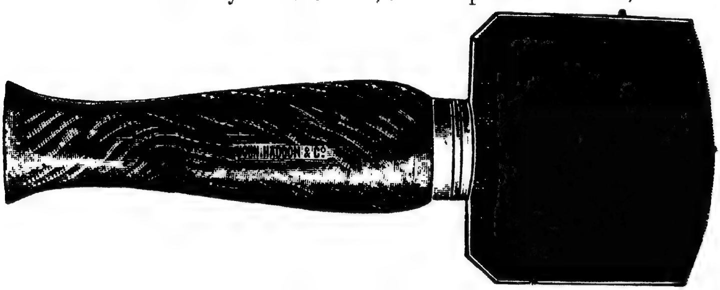


Fig. 115.—Rocker.

the second half of the eighteenth century. In Le Prince's aquatint process a dust of finely ground asphalt or resin is caused to fall over the copper plate, which is then gently heated so as to cause the minute particles to adhere to the plate, but not to melt and flow together. The superfluous dust is blown off, and the plate then receives the design. Wherever the resin does not cover the plate, the etching mordant will bite into the copper.

In another variety of the process, invented by Stapart, but not much used, the plate receives a thin coating of transparent ground, which is kept fluid by heat. Finely sifted ground sea salt is then scattered all over it, and falls through to the surface of the copper. The ground is then allowed to dry, and the salt is dissolved by water, so as to leave the copper exposed to the action of the etching acid in minute points as before.

More usually, the resin is dissolved in rectified alcohol, prepared in different strengths. When this dries on the plate, it produces a granulation finer or coarser according to the strength of the solution.

A similar effect can be produced by covering the plate with

the usual etching ground, then placing fine sand paper or emery paper over it face down, and pulling several times through the press under pressure. This is known as *sand paper aquatint*.

Whichever method of preparation is adopted, the subsequent process is the same. The design must be transferred to the prepared plate in the usual way, and the engraver then proceeds as in line etching. Portions that are to have no tone at all must be stopped out with Brunswick black. Aquatint gives an even tone, and the general effect is not so opaque as mezzotint.

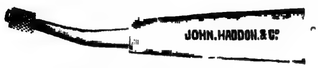


FIG. 116.—Roulette.

The Crayon Method.—The chief tools of the crayon method are the *roulette* (Fig. 116), a little revolving toothed wheel in a handle, the *mace-head* or *mattoir* (Fig. 117), a kind of small toothed club, and the *échoppe*, a sort of oval-pointed burin The plate is covered with etching ground, and the crayon drawing is then transferred to it. The roulette is next passed up and down the lines, the mattoir and the échoppe being used after it. The plate so treated is then etched with acid and printed in the colours desired.


FIG. 117.—Mace-head.

Stippling.—In stippling, the engraver works on a plate covered with etching ground with single and double needles of various shapes and sizes. He perforates the ground down to the copper surface with irregular dots, which are large and close in the dark parts, but finer and wider apart in the lights. The work is then etched in the usual way. The most delicate shading is done direct on the dry bare copper after etching.

Stippling is a process of great delicacy, giving very subtle gradations. Next to mezzotint, it is the best method for reproducing paintings.

Colour Printing.—If a subject engraved in the above ways has to be printed in more than one colour, several methods may be adopted. All the colours may be applied to the same plate, each in its proper parts of the design, and the plate can then be pulled through the press with the paper over it. This is practically a painting process. Alternatively, there may be a plate for each colour, each plate showing only the parts of the work that are to print in one particular colour. In this case, it is most important to take steps to ensure that the various printings shall be in proper register with one another. Thirdly, there is the three-colour process introduced by a German, Jacob Christoph Le Blon, in the early eighteenth century. This is based upon analysis of the colours of the design into combinations of the three primaries, red, blue, and yellow (see p. 127), and only

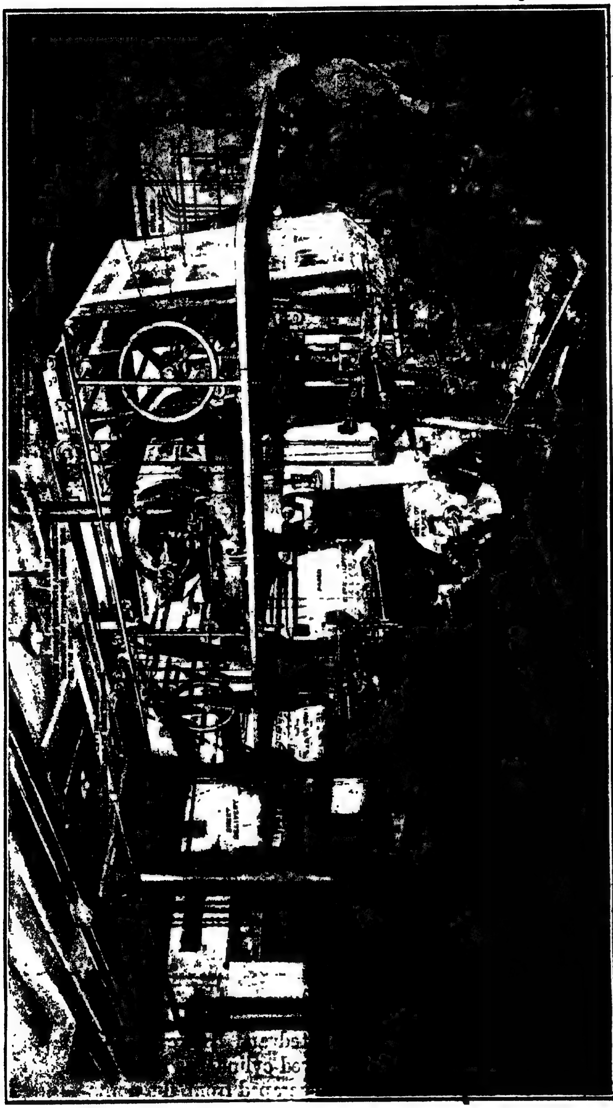


FIG. 118.—Rotogravur Printing Machine.

three plates are required for printing. The colours are superimposed and combined as in modern three-colour printing, but the analysis of the design before the days of photography must have been a very difficult task.

Photogravure.—Having briefly described the chief hand engraving processes, we must now describe the process of photogravure, which is commercially much more important. Photogravure is akin to aquatint, but the design is placed on the plate photographically instead of by the hand of an artist, and it is now possible to print from the etched plate a very large number of impressions at the rate of 3000 an hour.

The copper plate for photogravure is prepared with resin dust, as already noted in the first aquatint method. A photographic negative of the subject to be printed is obtained, and a positive transparency is made from this. A print from this transparency is made on a carbon tissue, which is then pressed close down on the prepared copper plate and developed. The edges and back of the plate having then been protected by varnish in the usual way, the plate is subjected to etching in perchloride of iron solution of various strengths. The etching will be deepest in the shadows of the original picture and least in the high lights. Very fine prints can be obtained from such an etched plate, possessing depth and softness quite foreign to half-tone work, and moreover it is unnecessary to use a shiny, coated paper for printing them.

Commercial Photogravure.—In order to make it possible to print photogravure plates rapidly in large numbers, and so make the process of commercial value, the carbon tissue print, before being laid down on the copper plate, is exposed under a very fine ruled screen similar to, but much finer than, those used in making half-tone blocks. This breaks up the surface into very minute dots, and makes the engraved plate able to stand the rougher usage of the quick-printing machine.

The original form of this process was known as *Rembrandt photogravure*, and a further development is represented by the *Rotogravur process*, in which the engraved surface is a copper cylinder instead of a flat copper plate. This Rotogravur machine (Fig. 118) runs at 3000 revolutions an hour, and can print both pictures and letterpress simultaneously. The paper is fed to the machine in a continuous roll, and is cut into sheets before delivery by a rotary cutting knife. Both sides of the paper are printed in the one run of the machine, there being two engraved copper cylinders, with between them a steam drum to dry the paper after one side has been printed and before it passes on to the second cylinder. Each engraved cylinder is inked by means of an inking roller, and the ink is scraped from the non-printing parts of the surface by a knife called a *doctor*.

CHAPTER XXX.

ESTIMATING AND COSTING.

The Relation of Estimating to Costing.—Nearly all commercial printing work, whether lithographic or letterpress, is obtained after estimates have been asked for and submitted, and therefore a sound system of estimating is of the utmost importance. The estimate must be low enough to obtain the order, but on the other hand it must be such as to provide for a reasonable margin of profit after meeting all kinds of expenses. The basis of sound estimating is accurate costing; that is to say, the probable costs of new jobs can only be ascertained on the basis of the correctly worked-out costs of jobs already completed. Accurate costing can be attained only by the adoption of a reliable system of records, and by the application of sound principles of allocation in regard to all charges. The ascertained costs of every job should be compared with the estimated costs as a guide in future estimating. It is recommended that the cost sheet for a job should be filed away along with the corresponding estimate in a good strong envelope, which might also contain paper samples, etc.

A Sample Estimate and Cost Sheet.—The following is a specimen lithographic estimate, with the corresponding cost sheet:—

ESTIMATE.

BLANK & DASH, GLASGOW.

3 *April*, 1914.

20,000 show cards. Design printed in two colours and tint. No printing on reverse side. Size 11 × 14 in.

Process.	Estimated Time. Hours.	Rate.			Remarks.
		s. d.	£ s. d.	£ s. d.	
Original work. Designing sketch	35	1 6	2 12 6		
Lithographing design	30	1	1 10		
Cost of three stones		5 6 each	16 6		
Polishing three stones	3	7	1 9		
Preparing originals and proving	9	10½	7 8		
Polishing three machine stones or plates	7½	7	4 5		
Transferring. Three stones or plates four up.	15	10	12 6	6 5 4	
Machining: (including machineman's and feeder's wages). 20,000 four up. Three changes of colour = 15,000 runs, machine No. 7	45	5		11 5	
Ink				15	
Cards: size 22½ × 28½ in. Weight 54 lb. per gross, 2½d. per lb. Quantity 35 gross		10 1½		17 14 5	
Cutting	7½	1		7 6	
Packing				7	
		Estimated cost	£	36 14 3	

COST SHEET.

12 *May*, 1914.

BLANK & DASH, GLASGOW.

20,000 show cards. Design printed in two colours and tint. No printing on reverse side. Size 11 × 14 in.

Process.	Time. Hours.	Rate. s. d.	£ s. d.	£ s. d.		Remarks.
Original work. Designing sketch	32	1 6	2 8			
Lithographing design	29	1	1 9			
Cost of three stones		5 6 each	16 6			
Polishing three stones	3½	7	2 1			
Preparing originals and proving	8½	10¼	7 3			
Polishing three machine stones or plates	7	7	4 1			
Transferring. Three stones or plates, four up.	14½	10	12 1	5 19		
Machining: (including machineman's and feeder's wages). 20,000 four up. Three changes of colour = 15,000 runs, machine No. 7	42	5		10 10		
Ink				17 6		
Cards: size 22½ × 28½ in. Weight 54 lb. per gross, 2¼d. per lb. Quantity 35 gross		10 1½		17 14 5		
Cutting	9	1		9		
Packing				6 6		
			£	35 16 5		
		Estimated cost	£	36 14 3		

The Elements in Price.—The price quoted for a job comprises three elements, namely (1) cost of production, (2) oncost or establishment expenses, and (3) profit. The *cost of production* is the value of materials and labour required for the job. The *oncost or establishment expenses* consist of a number of general charges in a business of which each job must bear a reasonable share, although they are not specially related to any particular job. They include such charges as rent, rates, taxes, depreciation, interest on capital, insurance, advertising, postage, office salaries, management expenses, selling expenses, bad debts, etc. Profit requires no special explanation. If the cost of production or the oncost charges for a job are underestimated, the profit allowed for may be swallowed up or more than swallowed up. Cost of production is easily ascertained by keeping correct works records in proper form for every job, but the allocation of oncost raises difficult questions of principle or method.

Cost of Production.—The cost of production or prime cost is obtained from records accurately kept in the works and entered up on suitable cards or into suitable books in the office. The following shows a sample page from an Orders Received Book for a lithographic house:—

ORDERS RECEIVED BOOK.

Date Received.		From Whom Received.	Description.	Departments.			Materials, etc., Wanted.	Order Completed.		Remarks.
				Artist.	Proof.	Machinery.				

The number of columns under the heading "Departments" may be extended as much as necessary.

The next form shows a sample page from a Machineman's Book, giving essential information for ascertaining prime cost.

MACHINEMAN'S BOOK.

Date.	Hour of Starting.	Name of Work.	No. of Job.	No. of Impressions.	Colour.	Lb. of Colour Used.	Hours Making Ready Machine.	Time Delayed. Cause.	Hour of Finishing.	Date.	Total Hours from all Causes.

A suggested form of Artist's Time Book is here given, and the same form might be used for proving, transferring, and other departments.

ARTIST'S TIME BOOK.

Date.	Time. / Hours.	Description.	Remarks.

Two Forms of Oncost.—Oncost or establishment charges can be analysed under the two headings (1) Departmental Expenses and (2) Office Expenses. The former consist of the (so-called) unproductive expenses of the department where a business is organized in departments. They are a factor in production, although they do not enter into the cost of the job in the same direct way as materials, machine time, etc. Office expenses are not concerned with production in any direct way at all, but include the general expenses of administration of the business as a whole and all selling expenses. Every department must bear a reasonable share of these general non-departmental expenses.

Departmental Oncost.—The number of departments in a lithographic business will depend upon the size of the business to some extent. The following may be mentioned as usual departments: paper store, artists' department, stone and plate preparing department, transferring and proving department, machine room, finishing departments, packing room. Departmental on-

cost consists of unproductive wages or salaries in the department, its share of rent, rates, and taxes, light, heat, power, repairs, etc.

It is usual to charge departmental expenses against each job in the hour rate. The hour rate for a machine, for instance, is so fixed as to recover not only the actual wages cost but as nearly as possible the proportion of the departmental oncost (rent, etc.), properly belonging to it. The proper rate can only be ascertained by experience, and may have to be revised every year on the basis of the previous year's results.

Office Oncost.—Office oncost or administrative expenses are allocated in a different way from departmental oncost. Each department has to bear a percentage of the total office oncost corresponding to its productive costs, that is, its cost in labour and material. It is a mistaken system to make the allocation in proportion to the total cost of a job, including all departmental charges.

CHAPTER XXXI.

THE TRAINING OF APPRENTICES.

Explanation.—An apprentice is a young person who, by legal document or otherwise, has agreed to serve an employer for a certain number of years with the object of learning a trade; the employer on the other hand promising to teach the young person the particular trade agreed upon in return for faithful services, wages to be paid according to the custom of the trade. Until recently nearly all apprentices were indentured, that is, the agreement was of a legal, binding nature, but now it is considered that the agreement should not be binding, so that it may be open for either party to make a change should circumstances necessitate such.

An Expensive Luxury.—The remark was recently made that apprentices were an expensive luxury and the speaker could not afford to keep them. Such a statement, however, could only emanate from a very unpractical person. An apprentice will be an expensive luxury or a valuable asset to the business according to the training he receives from those in charge, but every firm should consider it their bounden duty to train apprentices in proper proportion to the number of journeymen they employ. A common mistake that is often made, and one that is expensive and unprofitable to all concerned from every point of view, is to attempt to train too many.

Responsibility of Employers.—An employer upon engaging an apprentice must recognize that he has taken upon himself the responsibility of teaching the lad his business in a manner calculated to make him a capable and efficient workman. If the employer cannot personally supervise the lad's training, then he must hold his manager or overseer responsible for it. If the lad shows no aptitude for the business within three months to six months from commencing, his parents should at once be communicated with and the question of a change of employment considered.

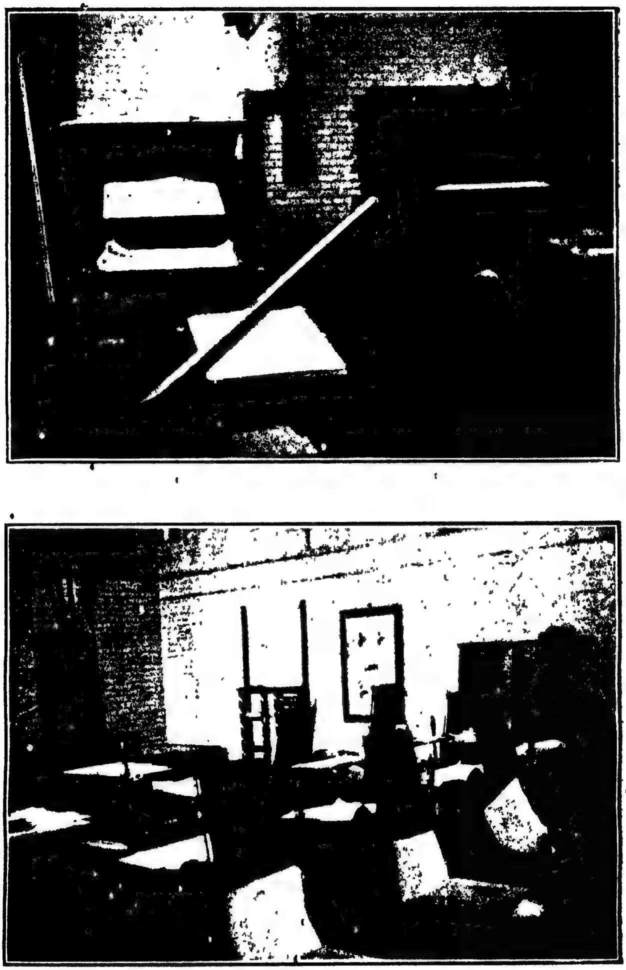


FIG. 119.—Litho Class Room, the Royal Technical College, Glasgow.

An Apprentice Guardian Committee.—As already pointed out, an apprentice is an expensive luxury to all concerned if his training is not carried out in an efficient manner; therefore if only from a purely economic standpoint, the trade society should jealously guard the apprentice from the first day he casts his eye upon a lithographic stone. The employer is in exactly the same position, and therefore an Apprentice Guardian Committee consisting of thoroughly practical men representative of the employers and the trade societies should be formed in all lithographic centres. It would be the duty of this committee to outline a scheme of progressive training covering the full term of apprenticeship, which would include evening studies such as arithmetic and elementary mathematics, English language and literature, elementary science, history, and citizenship during the first four years, the committee always keeping in view that while it is good to train a young person to become a *good workman*, it is still better to make him also a *good citizen*. It would also be the committee's duty to listen to the grievances of the lads and, in the interests of the trade, to see that they are receiving fair treatment; also to examine them periodically in technical matters, the first examination to take place six months after commencing. This would give the committee an idea as to the suitability of the lad as a lithographer, and also give the lad an early opportunity of trying his hand at an occupation more in harmony with his individuality. The other examinations need only take place yearly after that, and the lad should receive a certificate after each showing the progress he has made. If, at the end of each term, his progress is not considered sufficiently good, the committee should advise the employer and make arrangements for his remaining for a further period at the same work. On the other hand if, after five years' service, the committee find the lad in a backward condition through no fault of his own, or it is considered that the employer is not in a position, from want of modern machinery, to carry out the completion of the training, the committee should make arrangements accordingly for his transference to another shop; the sole consideration of this committee being the *complete education of the apprentice*.

The Term of Apprenticeship.—The number of years which constitute the term of apprenticeship in the lithographic trade is usually arranged by mutual agreement between the employers' association and the trade society. In Britain the recognized term is seven years; so in order to become a journeyman at twenty-one years of age an apprentice must commence at fourteen. Whatever term may be decided upon in future, the Apprentice Guardian Committee should have the power to increase it if from any cause the lad has not become proficient. A term

of six years is considered by many to be a sufficiently long period in which to learn the lithographic business, provided that a systematic and careful training is carried out. This modified term would give the committee a year or two to work on with backward apprentices if considered necessary, and would not be unduly hard on the lads. It would also encourage a young man to do his very best during his apprenticeship, which would not only be good for himself, good for his employer, and good for the trade society of which he must ultimately become a member, but would also be good for the community at large. To demand that an incompetent tradesman must receive the full standard rate of wages simply because he has spent seven years working at the trade is, to say the least, an outrage against common sense, and is bad economy from every possible standpoint.

Suitability of Lads.—Any lad of ordinary intelligence, provided that he has a natural liking for pictures and colours, and is interested in machinery, may assume that he possesses some of the principal qualifications necessary to warrant his commencing a term of apprenticeship as a lithographer. It is only on a very rare occasion that a lad of fourteen years will show some such outstanding quality that will at once decide for him a great future career, and if there is one quality that should stand out from all others in the lad who aspires to lithography, it is the *quality of cleanliness*; cleanliness in person and cleanliness in habits. The careless, slovenly lad never succeeds in lithography, nor should he be tolerated. It should be distinctly understood, however, that the average lad of this age knows nothing of business or of factory life, and that he cannot be held responsible if, after he has been at the trade for some little time, he should find the work irksome, or the employer should consider him unsuitable; but opportunity and training will soon bring to the surface all the hidden and undeveloped virtues from below, and a very few months will be sufficient for either party to come to a decision regarding the future.

An All-round Training Necessary.—Lithography, being a chemical process and one that is susceptible to many influences, demands from the operator a thorough and complete knowledge of the whole routine. A theoretical knowledge is not sufficient. To be successful he must have a thorough practical knowledge as well; nothing else will do. Hundreds of intelligent men in the trade are suffering to-day for the want of this all-round training, and it is not only they who suffer, but the trade as a whole must suffer also. Some men have spent their seven years pulling transfers from original stones, it having been discovered while they were very young that they could do this and that it paid, and so the firm kept them at it until they became journey-

men. There are also men who were taught only to print a note heading and an invoice in black ink, and they were kept at this by the firm until they became journeymen. And so the trade is paying the penalty to-day for the sins and the ignorance of the past, but we do not blame these men. Let the Apprentice Guardian Committee of the future see to it that they *first make all-round tradesmen*, and afterwards specialists.

A lithographic apprentice must commence at the bottom, that is, he should learn to grind, level, file, and polish a stone properly, and also acquire a knowledge of the preparation of a metal plate for the reception of a lithographic drawing or a transfer. One week spent watching an experienced man, and another week or two doing actual work, will be sufficient for the moment in this department, provided that he receives proper instruction. He might then with advantage be transferred to the proving room or the transferring room, where he could spend a month watching and assisting the prover or the transferrer. Here he would learn to wash the cloths and sponges and be instructed in the necessity for using pure, clean water. He would learn to clean and oil the press, and lubricate the tympan, and he would receive practical instruction in the proper methods of washing, scraping, and taking care of nap, glazed, and rubber-covered inking rollers, also the use of acids and gum and the process of washing out the work. He might then be given a small hand press upon which to do actual work, and would be supplied with the necessary tools, which should consist of a black-ink hand roller and a pair of stout leather handles, a small palette knife and a broad slab-knife, a pair of scissors with four-inch blades, a steel scraper, a few slips of polishing stone of various thicknesses. Acid brushes and touching-up brushes, a small steel straightedge, a pair of dividers, and a lead pencil will complete his outfit for some time to come. Now let him have a stone containing some old original or other work of no value with instructions to wash it out in the manner he had been shown and then pull a number of black impressions on waste paper, submitting one for approval. After working at this for some time, he might substitute transfer ink for the black ink and repeat the operation first on plain paper and afterwards on transfer paper. When he has done this in a satisfactory manner, he should patch up the transfers on a sheet in regular fashion, and transfer them to a stone which he has previously polished and prepared for them, and then carry right through the process of rubbing-up the work with a black ink dauber, dusting it with resin, cleaning, etching, gumming, and finally taking proofs.

If some such system as suggested above is carried out, and it will be admitted that system is a very important factor in the

training of apprentices, it will be found that in less than six weeks' time the lad will be capable of printing small jobs in the hand press in a very creditable manner, and it cannot be too strongly emphasized that the more of these small jobs that can be put his way the better, for undoubtedly this is the proper time and place to impress upon his mind the meaning of the words *printing quality*, and also for him to learn the fundamental principles which underlie the art, for no amount of work in after life can ever make good the lack of this knowledge.

A Suggested Course.—The following may be useful as a suggested course of training covering the full term of apprenticeship:—

First Year. Under the supervision of stone polisher and metal plate preparer, two weeks. Under supervision of prover and transferrer, one month. Pulling transfers from stone and from copperplate, transferring, and printing same at hand press, six months. Proving and printing, four and half months.

Second Year. Similar to previous six months, but to include patching and transferring small jobs for machine. In all cases carrying through the work from beginning to end whenever practicable.

Third Year. More advanced work, including transferring to metal plates: also enlarging and reducing and coating transfer papers.

Fourth Year. Printing good plain black and colour commercial work on small flat-bed machine, spending first two weeks assisting and being instructed by a careful and competent machineman, transferring and preparing his own work whenever possible.

Fifth Year. Printing good black and colour work on larger flat-bed machine.

Sixth and Seventh Years. Printing good black and colour work on direct printing and offset printing rotary machines; spending the first two weeks assisting and being instructed by a careful and competent rotary machineman.

Technical Education.—The question of technical education is an important one and should receive the most careful attention from employers, managers, and those in charge of apprentices. Technical education may be divided into two branches, namely, theoretical and practical. Whether it will be necessary for the apprentice to attend special classes for instruction in either of these branches will depend entirely upon the opportunities at his disposal in the workshop. The workshop possessing an adequate and up-to-date plant is undoubtedly the best training ground for practical work, but unless provision is also made for instruction in theory, it is most essential that the lad

should attend a special class for this. The apprentice who has acquired a sound theoretical knowledge as well as a thorough practical training is the lad who is going to be of most service to his employer and to the community generally. Theoretical instruction should be dispensed to the student in a simple but efficient manner, commencing from the time of his initiation into the trade, and for the first three or four years it should be imparted to him once a week during part of a working day and not after hours, it being now generally recognised that to obtain the greatest benefit from instruction of any kind, both body and mind should be in a fit condition to receive it. This instruction should be given by a thoroughly qualified teacher, the apprentices being graded according to the time they have been at the trade, each grade receiving its instruction at different times.

THE END.

THE ART OF LITHOGRAPHY.

COMBINED INDEX AND GLOSSARY.

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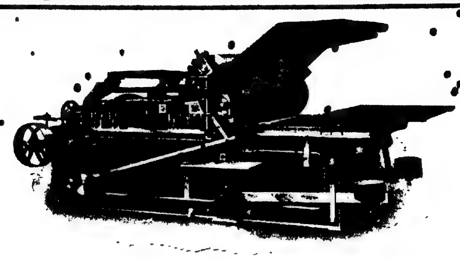

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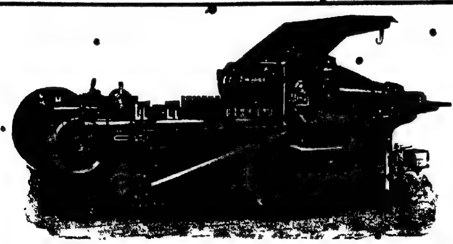

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